THE IMPACT OF BLOCKCHAIN TECHNOLOGY ON INFORMATION TECHNOLOGY GOVERNANCE

BY

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Abstract

This dissertation forms a hypothesis that Blockchain technology is giving rise to a new form of enterprise IT governance. Blockchain is a computational design that first emerged as the technology underpinning the popular cryptocurrency Bitcoin. Despite its use in cryptocurrency, it has an array of different use cases that may significantly impact the global economy. Some areas that Blockchain will affect were never truly re-engineered by the internet era, namely Economics and Governance. This dissertation is a qualitative exploration and analysis of blockchain's impact on Information Technology Governance. The research unpacks these implications by comparing governance in hierarchical organisations and decentralised autonomous organisations. The primary data is attained through a questionnaire and the secondary data from a case study. The research contains two literature reviews on Blockchain and IT governance. The primary finding of this research reveals that although conventional IT Governance will still be used in the future, fifty percent of the sentiments shared by subject matter experts indicate that unconventional governance will take precedence with decentralised autonomous organisations. This implies that changes in traditional governance frameworks may be required in the future.

Keywords: Information Technology Governance, Blockchain, Distributed Ledger Technology, Decentralised Autonomous Organisations

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Acronyms and Abbreviations

CIO	Chief Information Officer
COBIT	Control Objectives for Information and Related Technologies
CTO	Chief Technology Officer
DAO	Decentralised Autonomous Organisation
DAPP	Decentralised Application
DLT	Distributed Ledger Technology
ETH	Ethereum
EDM	Evaluate, Direct, Monitor
ITIL	The Information Technology Infrastructure library
ISO	International Organisation for Standardization
ITG	Information Technology Governance
IT	Information Technology
ISG	Information Security Governance
KPI	Key Performance Indicator

Declaration

I certify that the dissertation submitted by me for the degree Master of Commerce (Information Technology Management) at the University of Johannesburg is my independent work and has not been submitted by me for a degree at another university.

Melina Mutambaie Katende

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1. Chapter 1 – Introduction

1.1. Introduction

1.1.1. Background

There has been a growth in the use of Blockchain technology since 2008. Experts believe this shift in computing paradigms may result in the re-engineering of economics and governance (Swan, 2015; Tapscott, 2015; Mougayar & Buterin, 2016).

This shift began with a cryptocurrency called Bitcoin- a currency not backed by a central authority (Swan, Blockchain - A Blueprint for a New Economy, 2015). Bitcoin exists on a digital public ledger known as Blockchain. The technology is built with a self-policing security policy that uses cryptography to secure transactions (Swan, Blockchain - A Blueprint for a New Economy, 2015).

Between 2008 - 2017, there have been numerous Blockchain innovations launched following the success of Bitcoin. Examples include advanced supply chain systems that promote transparency and traceability in logistics (IBM, 2017), as well as crowdfunding systems where donations and transactions are publicly visible (Rosic, 2017). Experts are exploring the answers to questions like "Will there one day be a need to provide assurance over the algorithms, code and smart contracts that underpin this technology?" (Thomson Reuters, 2017). Another question they ask is "How will these new technologies be regulated?" (Deloitte, 2017.). These types of questions have sparked the curiosity and desire to explore the possibilities as well as highlight the challenges of this topic.

Blockchain technology could become an embedded economic layer of the web that serves as a foundation for payments and any form of decentralised value exchange. The potential benefits of Blockchain are more than just economic—they extend into political, humanitarian, social, and scientific domains (Swan, Blockchain - A Blueprint for a New Economy, 2015). With the potential to re-engineer all human endeavours as pervasively as the internet boom did.

This dissertation focuses on the nature of Blockchain, the developments that have caused disruptions and how Information Technology Governance (ITG) frameworks such as the Control Objectives for Information and Related Technologies (COBIT),

may need to extend their principles and guidelines to incorporate decentralised autonomous organisations.

1.1.2. Research Goals

The goal of this research is to develop an inductive theory that substantiates the premise that Blockchain could disrupt the conventional role of IT directors in organisations that transition to or operate entirely on this technology, thereby impacting IT governance.

1.1.3. Research Objectives

The main objective of this study is to provide a sound hypothesis based on the premise. The intention is to prove that through this disruption Blockchain could lead to the evolution of traditional governance frameworks. The following research objectives highlight from which angles this topic is addressed:

Objective 1 - Explain the conventional ITG Frameworks by using COBIT as the main frame of reference.
Objective 2 - Explain what Blockchain technology is and discuss its implications.
Objective 3 - Conduct an in-depth case study on an existing Blockchain application that challenges governance.
Objective 4 - Identify patterns and processes that could substitute conventional IT governance.
Objective 5 - Identify the impact that Blockchain could have on IT governance in the future.

1.1.4. Research Questions

This inductive research aims to formulate a valid hypothesis surrounding the impact of Blockchain by answering the following questions:

- How are enterprises governed on Blockchains?
- Are IT governance frameworks like COBIT fully applicable in Blockchain organisations?
- What are the future implications of the technology on roles like Chief Information Officer (CIO) and Chief Technology Officer (CTO)?

1.1.5. Layout

The remainder of this chapter is laid out as follows:

The problem statement is discussed in the next section, followed by a synopsis of the research process to be conducted. The research deliverables are then listed and explained. Finally, the layout of the dissertation is explained in the last section of this chapter.

1.2. Problem Statement

Given the rise of Blockchain technology, the chosen subject is relevant and applicable to industry professionals for the following reason:

In the IT field, there are certain epistemological issues surrounding the nature and scope of knowledge when it comes to physical and virtual domains, where the relationship between the two variables is unconfirmed (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017).

Due to the different natures of these two worlds, it can be challenging to establish correspondence between the two. This is because the virtual world is more quantitative (digital ones and zeros), and the physical world is qualitative (chaotic, variable, irrational) (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017).

One implication of transferring value with Blockchain networks instead of relying on human-based institutions is that intermediaries may become obsolete (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017). Consequently, the institutional structure of society could possibly shift to one that is computationally based (Swan, Blockchain - A Blueprint for a New Economy, 2015) , thus reducing the need for institutions to be governed by humans.

In saying that, and with a lack of widespread knowledge on these ideologies, there is little guidance on the implications of Blockchain on ITG, particularly for roles like the CIO and the CTO. In due course, different studies may come to identify the computational equivalents of human-based qualities that are held by CIOs and CTOs,

such as tacit knowledge, values, ethics, strategic thinking and intuition. For now, we are still in the early days (Swan,2015).

With that being said, it is important to note that continuous exploration is required to address the various implications of decentralisation and distributed ledger technology in society.

1.3. Research Process

The focus of this qualitative research process has been on gaining insight and identifying patterns from subject matter experts, literature reviews and a case study. Additionally, it has been important for the researcher to immerse herself in the industry to fully understand the dynamics and ideology of decentralisation. The following research process was used to develop the main theory:

1. Exploration: Examining the Empirical World
   Inductive reasoning begins with detailed observations of the world, which moves towards more abstract generalisations and ideas (Dudovskiy, 2011). This phase lays the foundation of the research by examining the appropriate variables and their relationships. The result of this phase was captured in Chapter 2 and 3, Literature reviews on Blockchain technology and IT governance.

2. Designing a Research Strategy
   This phase is demonstrated in Chapter 4, Research Methodology and Design. This process involved designing an appropriate research approach by exploring different philosophies and selecting the most suitable one for this research. Chapter 4 also details the selection of research strategies, data collection methods, techniques.

3. Data Collection: Gathering Evidence
   This step involved gathering qualitative data from subject matter experts. Blockchain experts were approached and asked to complete a questionnaire on the implications of Decentralised Autonomous Organisations (DAO) on the role of IT Directors. The data was gathered online. To support this primary data,

secondary data was gathered through a case study of an existing Blockchain platform called DAOStack.

4. Data Analysis: Analysing the Evidence
   This phase entailed a thematic analysis of the primary data and a comparative analysis of the secondary data. From this analysis, inferences and recommendations were made. This is documented in Chapter 5, 6 and 7.

5. Developing a Theory
   The inductive approach requires that the emergence of the hypothesis be based on the data collected. A substantial body of qualitative data was synthesised and used to formulate concepts that are summarised in Chapter 7.

1.4. Research Deliverables

The researcher aims to propose that the comprehensive deliverable, the dissertation itself, highlights the topic holistically when all chapters and deliverables are considered. The dissertation consists of smaller deliverables laid out as follows:

1.4.1. Literature Reviews

The literature studies in this dissertation focus on IT Governance and on Blockchain Technology. These studies are based on published books, articles and governance guidelines. It is important to note that neither the author's interest in Blockchain nor its rising popularity in commerce should constitute the sound justification for these studies. However, the refined and carefully selected literature highlight relevant and imminent challenges that may affect the structure of future organisations. Chapter 2 and 3 provide in-depth explanations of Blockchain as well as of IT governance frameworks, particularly, COBIT and ITIL (Information Technology Infrastructure Library).

1.4.2. Case Study

In an effort to highlight real world examples of the applications of Blockchain and governance, a holistic case study was completed on a Blockchain based network for collective intelligence called DAOStack. This case study aims to establish the relevance of roles such as the CIO and CTO in DAOs.

1.4.3. Data Analysis

One of the key deliverables in this research is the data analysis chapter which systematically synthesises qualitative data using a method called thematic coding. Central to this method is the development of a coding template, which summarises themes identified by the researcher as important in a data set (Brooks & King, 2017). These themes are then organised in a meaningful and useful manner to address the dissertation topic.

1.4.4. Recommendations

The intention of the research is to develop objective and relevant interpretations of the data collected and of the literature reviews. The recommendations, which form part of Chapter 6 and 7, serve as an extrapolation of the data analysis. Through these recommendations the author provides suggestions that address the problem statement and can be applied in businesses, educational institutions, communities and governments. This deliverable brings the most value to readers who might want to understand how governance must be applied in DAOs and enterprises that make use of Blockchain in some form or another.

1.5. Dissertation Layout

This dissertation consists of seven chapters. The best way to read this dissertation is to follow each chapter sequentially to understand the context and assumptions. The list of chapters and their value is summarised in Table 1.1.

Table 1.1: Dissertation Layout

Chapter	Title	Description
1	Dissertation Introduction	Provides the background information and motivation for the research. Introduces the research topic, problem statement and details the layout of the dissertation.
2	Literature Review on ITG	Investigates the discipline of ITG to provide background for the subsequent chapters.
3	Literature Review on Blockchain	Investigates Blockchain technology to provide context and background for the subsequent chapters.
4	Research Methodology and Design	Provides information on best scientific research practices. The researcher's acquired knowledge from this exercise enables her to make informed decisions whilst forming the research design.
5	Case Study on DAOStack	Investigates a real-world application of Blockchain where governance is programmable. It includes a comparative analysis of decision-making factors in DAOs versus in Hierarchical organisations.
6	Data Collection and Analysis	Synthesises and analyses the empirical data collected from primary and secondary data.
7	Dissertation Conclusion	Concludes the research by summarising the deliverables and presenting the unique value of the findings. The chapter also includes closing statements and key takeaways.

The next chapter is an introduction to ITG, in the form of a comprehensive literature review.

2. Chapter 2 - Information Technology Governance

2.1. Introduction

For a long time, organisations around the world have been working to define ITG (Tabacek, IT Governance Roundtable : IT Governance Frameworks, 2008). Over time that definition has changed. In the early 2000's ITG was defined as the measurement and control of enterprise IT but has since evolved to providing frameworks, mechanisms and methodologies for aligning business needs while delivering sustainable enterprise IT (De Haes & Van Grembergen, 2016).

ITG not only helps directors make better decisions, but also encourages leaders to control and monitor structures, processes and responsibilities required to keep a company's IT infrastructure afloat (Howard, IT GOVERNANCE FRAMEWORKS, 2008).

2.1.1. Background

The current climate of enterprise IT and its cost implications has set a high expectation on IT resources around the globe (Price Waterhouse Cooper, 2017; Deloitte , 2017). However, it is important to note that in any organisation, leadership of IT must begin at a board level (Von Holms & Von Holms, 2008).

This literature review defines ITG, explores ways to effectively implement its frameworks, as well as discusses some best practices. Moreover, this review reveals that the general consensus from experts is that ITG has become undeniably significant in all enterprises, especially with the adoption of emerging technologies.

2.1.2. Goal

The goal of this chapter is to lay the research foundation for the dissertation by exploring various literature studies on ITG. This chapter covers ITG and its subset - Information Security Governance (ISG) – before it delves into the COBIT framework in detail.

2.1.3. Chapter Layout

The first section of this chapter focuses on defining ITG and exploring different frameworks. This section also describes corporate governance, ITG and ISG. The

second section examines the principles of COBIT. The last section discusses the evolution and modern-day use of ITG and how enterprises can be more efficient by combining different governance frameworks.

2.2. Defining ITG

2.2.1. Corporate Governance

To better understand ITG, it is necessary to define corporate governance. This is because ITG is a subcategory of corporate governance. Corporate governance is defined as a system by which a company is directed and controlled (International Compliance Training, 2015; ICAEW, 2018).

The purpose of corporate governance is to facilitate decision making that supports the long-term success of a company by ensuring effective and prudent management. The responsibility lies on the board of directors of a company. The board is typically appointed by shareholders and or stakeholders. Members of the board are collectively responsible for setting the company's strategic goals and providing the leadership to put them into effect. They are also responsible for supervising the management of the business.

The actions taken by the board of directors sets the precedence for the company's values and objectives. This ultimately affects the integral parts of the system, including IT governance (Von Holms & Von Holms, 2008).

In 1998, the Organisation for Economic Co-operation and Development (OECD), an intergovernmental economic organisation representing 35 countries, established its own principles of corporate governance (OECD, 1999). This set of corporate governance standards and guidelines were agreed on in 1999 and have since formed the basis for corporate governance in OECD and non-OECD countries (International Compliance Training, 2015).

2.2.2. ITG

In 1998, the Information Technology Governance Institute (ITGI) was established as an arm of the Information Systems Audit and Control Association (ISACA). ITGI developed COBIT with an aim to advance the standards and approaches in directing and controlling IT within enterprises (I.T Governance Institute, 2013).

Over the years, COBIT along with other frameworks have helped mould the definition of ITG. Its origins were in control and measurement, but it has since moved and progressed into front-end planning and putting processes in place (Tabacek, IT GOVERNANCE ROUNDTABLE: IT GOVERNANCE FRAMEWORKS, 2008). ITG is now more a preventative discipline; it provides a framework for conducting business and guides decision makers in monitoring the progress and controlling business alignment with IT.

The governance of IT requires that mechanisms and methodologies involve people and that there is compliance with rules and regulations (Howard, 2008; Gartner 2012). It is the responsibility of the board of directors to meet and deliberate how ITG should take place within their organisation (Howard, IT GOVERNANCE FRAMEWORKS, 2008).

As in integral part of enterprise governance, ITG consists of the leadership and organisational structures that promote the organisations IT by extending the strategies and objectives throughout the organisation (ISACA, 2008).

Although variations of the definition can be found in numerous literatures (SAICA, 2017), fundamentally the definitions comprise of the following aspects:

- Accountability of IT
- IT compliance to rules and regulations
- Satisfying the needs of the board and stakeholders
- Managing IT risk
- Providing value to the business and control of work done

2.2.3. ITG Frameworks

There are three widely recognised vendor neutral frameworks that are used for ITG (IT Governance, n.d.). Although these individual frameworks can be used on their own, they are often used in combination because of their unique governance strengths (Hill et al., 2006). Below is a list of these three frameworks with a brief history of each:

I. ITIL

The Information Technology Infrastructure library (ITIL) was first developed in the 1980's by the United Kingdom's Cabinet office (ITIL Central, n.d.). The office was tasked with developing a framework for efficient and financially responsible use of IT resources within the British government and the private sector (ITIL Central, n.d.). ITIL is supported by ISO/IEC2000:2011 (IT Governance, n.d.).

II. COBIT

COBIT was created by ISACA. The fifth iteration of COBIT was released in 2012. It is an ITG control framework that guides organisations in meeting today's business challenges. It focuses on regulatory compliance, alignment of IT Strategies with business objectives and risk management.

III. ISO 27002

ISO 27002 is supported by ISO 27001, was created by the International Organisation for Standardization in 1995 (Rouse, 2013). It is a popular global best practice standard that focuses primarily on information security. The framework outlines 144 potential controls and mechanisms, which may be implemented subject to the guidance provided within ISO 27001 (International Organisation for Standardisation, 2013).

2.2.4. Information Security Governance

ISG is the responsibility of the board of directors and senior executives (Von Holms & Von Holms, 2008) and it forms part of the ITG framework (I.T Governance Institute, 2013). The rising tide of cybercrime and threats to critical information assets dictate that boards of directors and senior executives are fully engaged at governance level to ensure the security and integrity of those resources (Hufstedler, 2013).

The approach to ISG is to ensure that processes operate effectively from end to end, by minimising hidden risks. The following is a list of best practices of ISG (Diligent Corporation, 2016):

- Take a unified view of how ISG can impact your organisation.
- Create information security awareness and provide training.
- Constantly monitor and measure the organisation's information security.

- Maintain open communications with stakeholders.
- Promote adaptability and agility.

I. The Importance of ISG

The main goal of information security is to reduce the adverse impacts of acceptable levels of risks. (I.T Governance Institute, 2013). Information security ensures there is a protection of information assets. These should be protected from risk of loss, misuse, unauthorised access, damage or operational discontinuity (Morgan S. , 2017). It should also aim to protect assets from ever changing civil or legal liabilities that an organisation may face due to mismanagement (Von Holms & Von Holms, 2008).

Given the increase in cybercrimes such as phishing, malware and ransomware, few organisations are aware of the need for improved security measures (Morgan S. , 2017). Information security addresses three principal factors, namely confidentiality, availability and integrity throughout information life cycles (Von Holms & Von Holms, 2008).

The requirement to create a robust ISG framework continues to grow in the foreseeable future (International Organisation for Standardisation, 2013). By the beginning of 2018 alone, ISG spending has hit a worldwide high of USD93 billion dollars (Gartner , Morgan, 2018). Gartner's forecast on the cost of ISG includes corporate IT and categories such as outsourcing of IT security, consulting and implementation and data loss prevention to name a few (Morgan S. , 2017).

These figures indicate the impact and significance that information security has on organisations around the world. However, improving security is not just about spending on recent technologies (Deshpande, 2017). There has been a steady rise of security incidents around the globe, with PWC reported that the US Department of Homeland Security has identified more than 60 entities in US critical infrastructure where damage, caused by a single cyber incident, could reasonably result in $50 billion in economic damages (Price Waterhouse Cooper, 2017).

Further research has found that the use of Blockchain is more likely to be relevant in determining the integrity of transactions and may be critical in the Governance of Information Security (US National Security Telecommunications Advisory, 2017).

Organisations such as giant retailer Target have drastically improved their information security after a security breach in 2013 by completely reshuffling their board of directors and brining in new senior leadership with cyber security know-how (Gagliordi, 2017). These examples demonstrate that there is a vast need for effective ISG and ITG in enterprises around the globe.

2.3. ITG in Modern Enterprises

Governance is not just about making the right decision every time, it is about the process of decision-making (Chavira, 2017). Good processes ensure that when something goes wrong (or right) it is easier to trace what happened. This is something stakeholders want to be confident of before giving an organisation their buy-in (Molina, 2017). Organisations operate in internal and external environments simultaneously (Orbus Software, 2014), thereby increasing the impact of decisions made. For instance, one of the most common topics that customers of the European multinational software corporation, SAP, seek is to improve the overall performance of IT management (Shuptar, 2012).

Based on the definition of corporate governance, ITG can be described as having two distinct components i.e. a structural and process component. The structural component is the way technology activities are in alignment with business goals. The process component defines the rights and responsibilities of IT decision makers.

Assets such as relationships and ITG mechanisms form part of the process components, by answering the question of 'how' an organisation is governed (Shuptar, 2012). The structural components, such as mechanisms and systems put in place to enforce rules, the 'who' and 'what' (Shuptar, 2012).

The significance of ITG permeates right through to the financial and legal sectors of an organisation. This is due to the fact that many organisations have become dependent on information, communications and technology (ICT) (Giles, 2016). It is an essential element in making money, improving the customer experience, ensuring compliance and managing employees.

An ITG framework answers some key questions, such as; how the IT department is functioning overall? Which key metrics does management require to be effective? How can the return on IT investments be measured in an organisation? (Eshna, 2016).

It cannot be stressed enough that ITG is an on-going journey that will continually evolve (Tiglias, 2014).

2.4. COBIT Principles

The most recent version of COBIT is based on five principles that are essential for the effective management and governance of enterprise IT (IT Governance, n.d.). These principles are discussed in the following section:

2.4.1. Principle 1: Meeting stakeholder needs

Creating value is a priority for stakeholders, because it allows the organisation to maintain a balance between the optimisation of risk and realisation of benefits and use of resources (ISACA, 2012). The enterprise's IT goals are used to formalise a structure that the stakeholders rely on.

COBIT 5 provides some of the following required processes and enablers to support business value creation using IT. The COBIT guidelines can be customised to suit the needs of different organisations. This can be achieved by using the goals cascade. The cascade translates stakeholder needs into precise actionable goals within the context of the enterprise, IT related goals.

2.4.2. Principle 2: Covering the enterprise end to end

This principle explains how COBIT integrates governance of enterprise IT into corporate governance. All functions and processes within an enterprise are briefly discussed in Principle 5. The end-to-end governance approach lies at the foundation of the COBIT framework. The key components such as benefits realisation, risk and resource optimisation, as well as roles, activities and enablers (ISACA, 2012):

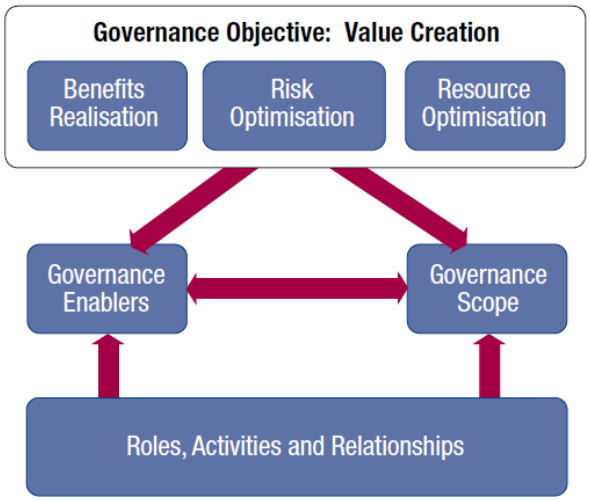


Figure 2.1: Governance and Management in COBIT 5

I. Governance Enablers

The organisational resources of governance lie in its enablers (ISACA, 2012). A lack of enablers may affect the ability to create value. Given the importance of governance enablers, COBIT 5 includes a single way of dealing with enablers that are discussed in Principle four (Enabling a holistic approach).

II. Governance Scope

It is possible to apply governance through different views, thus making it essential to define the scope of a governance system. COBIT 5 is designed to deal with different views of governance. It can be applied to an entire enterprise or a tangible or intangible asset. For example, an organisation that offers an online service requires a tailored governance system as opposed to an organisation that offers a physical manufactured product in the real world.

III. Roles, Activities and Relationships

The roles, activities and relationships aspect of the governance model defines who is involved in governance and how they are involved i.e. what their responsibilities and activities are and how they interact. A clear differentiation is made between the roles within governance and management activities.

2.4.3. Principle 3: Applying a single integrated framework

COBIT 5 is aligned with relevant other frameworks and standards such as ITIL, ISO27000 series and PRINCE II to name a few. This is important because it allows users of COBIT to have an overarching governance framework integrator (ISACA, 2012). It serves as a consistent and integrated source of guidance in a non-technical language.

2.4.4. Principle 4: Enabling a holistic approach

COBIT defines a set of enablers to support the implementation of a comprehensive and management system (Garsoux, 2013). The enablers consist of factors that individually or collectively influence the workability of a process. These enablers are driven by the goals cascade, whereby higher-level IT-related goals define what the different enablers should achieve (Orbus, 2016). They include:

1. Principles, policies and frameworks;
2. Processes;
3. Organisational structures;
4. Culture, ethics and behaviour;
5. Information;
6. Services, infrastructure and applications;
7. People, skills and competencies.

In terms of interconnectedness, enablers must be considered because each enabler needs the input of another enabler to be fully effective (Orbus, 2016). For example, processes need information and organisation structures need skills and behaviour.

Together, the principles and enablers allow an organisation to align its IT investments with its objectives to realise the value of those investments (IT Governance, n.d.).

As part of the overall study, the processes that allow directors to enable a holistic approach are significant for the subsequent chapters. COBIT 5 identifies five main governance process, they are as follows:

Table 2.1: ITG Processes

Process Code	Name
EDM01	Ensure Governance Framework Setting and Maintenance
EDM02	Ensure Benefits Delivery
EDM03	Ensure Risk Optimisation
EDM04	Ensure Resource Optimisation
EDM05	Ensure Stakeholder Transparency

2.4.5. Principle 5: Separating governance from management

Some scholars argue that there is no difference between management and governance, however, they are not to be confused because they are not the same (Bourne, 2015). COBIT advocates that enterprises implement governance and management by covering separate areas of work. The framework makes a clear distinction between governance and management. Figure 2.2 illustrates this distinction.

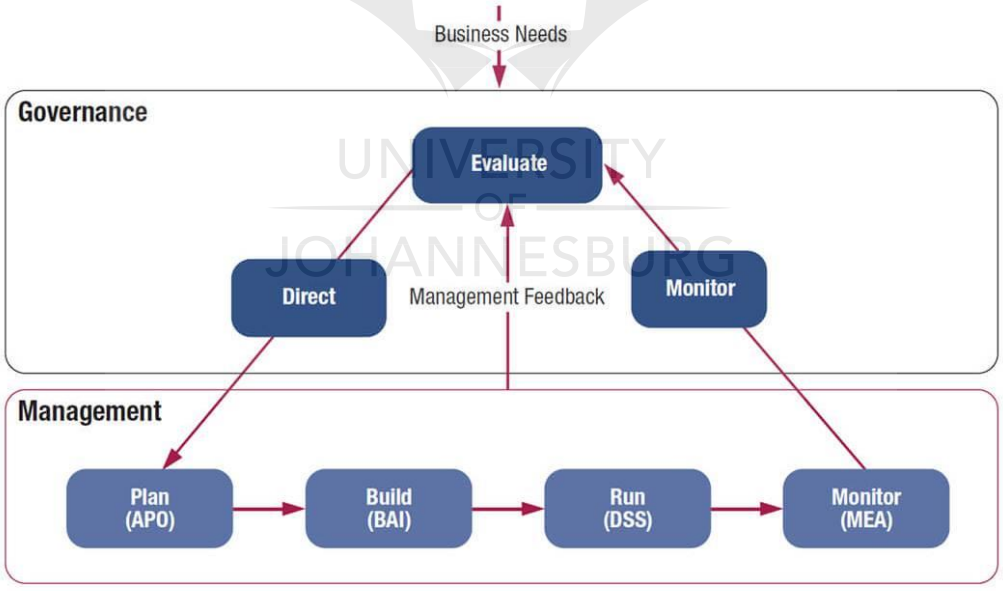


Figure 2.2: COBIT 5 Governance and Management Key Areas

An understanding of the difference between management and governance is critical for advocacy to be effective (Bourne, 2015). These two disciplines encompass several

types of activities and require different organisational structures and serve different purposes (ISACA, 2012).

The primary focus of the governing body should be to balance the competing interests of its stakeholder community (Bourne, 2015). According to COBIT (2016), governance is the responsibility of the board of directors under the leadership of the chairperson, and management is the responsibility of the executive management under the leadership of the CEO.

Management concerns the daily operations of the programme within context of the strategies, policies and processes that are enforced by the board of directors. Whereas governance is about “doing the right thing”, management focuses on “doing things right” (Tricker, 2000).

Figure 2.2 highlights the reference model for governance and management. IT Governance contains five processes that fall under the Evaluate, Direct and Monitor (EDM) categories. These will serve as the basis for the evaluation of governance in decentralised autonomous organisations in the subsequent chapters. Management contains four domains that cover planning, building, running and monitoring (PBRM). These are auxiliary processes that support but do not form part of the core governance discipline. Nevertheless, they are useful to consider in the evaluation of DAOs.

2.5. Combining COBIT, ITIL and ISO27002

Nearly all IT enterprises feel the need to gain or increase control, predictability, and efficiency (Alcyone, 2005). COBIT and ITIL together are a powerful force for IT Operational efficiency and effectiveness (Hill et al., 2006).

In general, COBIT is used for auditing purposes and ITIL is used to improve processes (ISACA, 2012). It is most effective to combine both at the initial stages of process improvement activities (Alcyone, 2005). For example, the COBIT framework leaves it to the organisation to define processes and procedures using the guidelines of software release policy as a control point. Due to its high-level coverage, COBIT can act as an integrator that brings disparate practices under one framework. It thereby helps to link strategic business practices (Hill et al., 2006).

ITIL, on the other hand, defines the best practices associated with Software Release Management. It describes how to implement Software Release Management within IT Outsourcing, as well as interfaces to other activities such as Infrastructure Deployment, Change Management and Configuration Management.

Enterprises that want to put their ITIL programme into the context of a wider control and governance framework should use COBIT (Gartner, 2002). This indicates that COBIT and ITIL are not mutually exclusive and can provide a powerful ITG guide.

The value of combining governance frameworks can be demonstrated in the following review. The following describes a typical public company's IT organisation and change drivers:

- Auditors often advise companies that their teams are not doing something right and structural changes are necessary.
- Businesses do not understand their needs or are not responsive to external changes.
- Executives want to make the IT organisation more cost effective by making improvements that fall within the year's operating budget.

ITIL and COBIT can enable organisations to achieve three objectives (Hill et al., 2006):

- Establish IT service management processes that can help achieve business and compliance objectives.
- Determine clear process goals and provide a means of measuring progress against them.
- Ensure that ITG is effective at process level. Empower IT departments to meet or exceeds the needs of external regulators.

The best practices in ITIL focus on methods and define a more comprehensive set of processes than COBIT, providing a roadmap for building those processes. However, it is still beneficial to make use of COBIT in conjunction with ITIL. COBIT helps organisations mould the ITIL processes to the business needs and goals of the organisation. It helps the organisation to determine where the organisation is now and

where the organisation should be in future. Knowing the goals, IT managers can then activate business objectives.

Below are some steps that can facilitate aligning governance frameworks such as COBIT, ITIL and ISO27002 (Office Governance Commerce, IT Governance, IT Service Management Forum, 2005).

2.5.1. Tailoring

- Using all three governance frameworks can help support governance by providing a management policy and control framework, ensure there is a return on investments and optimise costs (Hill et al., 2006). It can also help identify significant risks and assign responsibility for these risks, thereby efficiently organising resources to their sufficient capabilities (ISACA, 2012).

- Tailoring standards and policies based on the three frameworks can also help in defining service and project requirements. For example, setting clear IT objectives and metrics, or creating service level agreements (SLA) and contracts that can be scrutinised by clients. Specific guidelines on this can be found on ITIL and ISO27002 (Valentic, 2015).

- Tailoring the frameworks to a company's needs can ensure that the capabilities and competency of providers are properly verified. This can be done by contractual commitments or independent audits.

2.5.2. Prioritising

To avoid unfocused implementation of best practices, it is important that organisations prioritise how standards and practices are applied as well where they are applied. It is also important that the board of directors take ownership of ITG (Von Holms & Von Holms, 2008) and set a direction for the rest of the organisation to follow. To do this, the board can do the following (Office Governance Commerce, IT Governance, IT Service Management Forum, 2005):

- Ensure that IT stays on the board agenda.

- Ensure managers uncovered and address IT issues.

- Insist that the performance of IT is measured and reported.

- Establish IT Steering group or council.
- Help align IT imitative with business needs.
- Enforce a management framework is applied.

2.5.3. Planning

Planning is an activity that lies on IT managers, they can enforce all three governance frameworks by following the steps suggested (Office Governance Commerce, IT Governance, IT Service Management Forum, 2005):

1. Set up an organisational framework with clear objectives and list responsibilities.
2. Establish the current business objectives that IT is contributing to. This helps obtain a firm understanding of the business environment and the risk appetite. COBIT's management guidelines (Key Goal Indicators) address this step specifically. Used in conjunction with ITIL, SLA's can be defined to meet end-user terms.
3. Define and understand IT related risks.
4. Define target areas that are critical to managing the risks identified. For this step, COBIT's process frameworks can be used as a basis, which is underpinned by ITIL's service delivery processes and ISO27002's security objectives. These frameworks together help in assessing risks at the four main levels i.e. strategic, programme, project or operational.
5. Identify gaps in current capabilities. This can be done by performing capability assessments to establish where the improvements are required the most.
6. Put together improvement strategies and prioritise projects that contribute to the improvement of the areas defined in the previous steps.
7. Measure results by establishing mechanism to keep score of performance. COBIT's Key Performance Indicators can be used as a basis for this. It is important to consider the following:

a. Whether or not the organisation structure support strategy implementation.

b. Who is responsible for risk management?

c. Whether or not there is an existing infrastructure to facilitate and support the creation of business information.

d. If goals are effectively communicated throughout the organisation.

8. Repeat steps two to seven regularly.

2.5.4. Avoiding Pitfalls

Management ought to follow some pragmatic but essential rules while making use of all three frameworks. It is vital to treat the implementation of framework guides as a regular activity, as opposed to a “once off” step.

- The implementation will likely involve cultural changes; therefore, a key factor is enablement, and motivation.
- Avoid the imitative coming across as an exercise that is purely bureaucratic.
- Avoid the unfocused approach.
- Focus on areas that require the easiest change and build incrementally from there.
- Manage the expectations from all stakeholders.

2.5.5. Aligning Best Practices

The common theme in all three governance frameworks is that the best practices need to be aligned and integrated with the businesses’ requirements. COBIT can be used as an overall control framework, and ITIL and ISO27002 can be leveraged to address discrete areas.

2.6. Conclusion

From the literature reviewed in this chapter, it is clear that ITG is not a one-time exercise or something that can be achieved by mandates alone. It requires the board’s

commitment and a clear set of objectives and direction. As mentioned in COBIT, ITG must be incorporated into corporate governance.

The governance of enterprise IT spans over principles, policies and processes, organisational structures, cultures and ethics. Therefore, it is important that ITG addresses key areas such as strategic alignment, value delivery, risk and resource management, as well as performance measurement (I.T Governance Institute, 2013).

3. Chapter 3 – Blockchain Technology

3.1. Introduction

This chapter explores the technical and theoretical aspects of Blockchain. The chapter discusses how this technology goes beyond the use of cryptocurrencies (Blockchain 1.0) and smart contracts (Blockchain 2.0) and into distributed computing and disintermediation in various economic sectors (Blockchain 3.0).

3.1.1. Background

The roots of Blockchain stem back to the year 1991 (Springer, 1991). The very first work of cryptographically secured chain of blocks was documented by two computer scientists by the name of Stuart Haber and Scott Stornetta (Springer, 1991). The two proposed a computationally practical time stamping service to certify when a document was created or last changed. This technique made it not feasible for a user to back-date or forward a date a document but ensured the complete privacy and confidentiality of documents (Haber & Stornetta, 1991). Moreover, the time-stamping service would keep no record of the actual time-stamped documents.

Since then, numerous IT innovations have been developed using Blockchain and experts describe it as set of distributed databases known as “blocks” that contain records of digital transactions (Tapscott & Tapscott, 2017). These interconnected blocks support the decentralisation of systems and ensure that data is securely distributed and publicly visible. Many refer to Blockchain as a public distributed ledger.

Examples of blockchain use cases include advanced supply chain systems that promote transparency and traceability in logistics (IBM, 2017), as well as crowd funding systems that make donations and transactions publicly visible (Rosic, 2017).

3.2. Brief History of Blockchain

Since the emergence of Bitcoin, Blockchain has become synonymous with the cryptocurrency. That is because Bitcoin simultaneously represents three different things (Swan, 2015). Firstly, Bitcoin can be understood as the underlying Blockchain platform. Secondly, Bitcoin can refer to the protocol that runs on top of the Blockchain platform. Thirdly, Bitcoin (BTC) is the digital currency, the first cryptocurrency created.

Anderson (1996), a computer scientist at Cambridge University contributed to the Blockchain idea, which proposed a storage system to prevent denial of service attacks. Anderson (1996) presented a problem to cryptology communities that merited further study, suggesting limits to the resilience of distributed authentication services, and the write-once indexing of large databases. Anderson's research preceded that of Nick Szabo and Stefan Konst who further developed the theory that suggested practical, real life uses of Blockchains (Agarwal, 2017).

More than a decade later, on 31 October 2008, Blockchain was conceptualised into a fully functional system. A digital form of data structuring that enabled the sharing of public ledgers across a distributed network was introduced to the world through the cryptocurrency Bitcoin (Lewis, 2016; Maverick, 2017).

Following the global economic crisis in 2008, Satoshi Nakamoto (2008), released a whitepaper that explained a Blockchain protocol in the form of a Peer to Peer electronic cash system. Although the words "block" and "chain" were never used as one word in the original paper, in due course, the term was popularised as a single word (Bheemaiah, 2017).

Blockchain now extends into political, humanitarian, social and scientific domains (Lewis, 2016). The technological capacity of Blockchain has already been harnessed by specific groups to address real world problems (Swan, 2015).

In 2014, a popular discourse began to separate Bitcoin from Blockchain as industries recognised the endless number of uses of the technology (Mann, 2016). This gave rise to Blockchain 2.0, a computational concept that allows programmable transactions. The Ethereum network is an example of Blockchain 2.0 as it uses a computer language to write scripts that implement any computable function (Swan, 2015).

Vitalik Buterin, Russian Canadian programmer and writer for the Bitcoin magazine, co-founded Ethereum; an open source second generation public Blockchain featuring smart contracts (Agrawal, Van der Veer, Kirk, & Arnab, 2017).

To further elaborate the relevance of Blockchain to this study, the next section describes the growth and recent developments of blockchain in various sectors. This

becomes significant as background information and provides context for the subsequent chapters.

3.2.1. Blockchain Industry

Soon after the rise of Ethereum, start-ups began introducing Blockchain as enterprise solutions. In 2016, thirty of the world's largest financial institutions collaborated with R3; a technology company that leads a consortium of financial institutions, in researching Blockchain capabilities in the finance sector (Dalibard, 2017). Together they created an international distributed ledger platform known as Corda. Corda records and executes institutions' financial agreements (R3, 2018). Banks that form part of the group reckon the technology has the potential to make faster, more reliable payments that are easier to audit (Dalibard, 2017).

In March 2018, Deutsche Börse Group and HQLAX signed a letter of intent to form a strategic partnership for the creation of an innovative securities blending solution that makes use of the R3 Corda Blockchain platform (R3, 2018).

A year after the establishment of R3, the NASDAQ committed to a Blockchain trial, which was followed by three legacy financial institutions, namely; Visa, Capital One and Fiserv for a Blockchain called Chain. These big moves from the world's biggest financial players signalled the level of corroboration for the use of Blockchains within finance.

In October 2016, the world's first Blockchain centric Health conference was held where leaders from around the world gathered to explore how Blockchain could possibly transform their industry. The conference has continued to run yearly, bringing together the brightest minds to reimagine how Blockchain will streamline everything from payments, medical records, processing and analytics (Distributed Health, 2016).

In addition to finance and Health Care, Blockchain has gained popularity in the realm of digital identities (Marais, Windley, & Smolenski, 2018). For a long time, identity management has been a centralised process often controlled by government. With the emergence of self-sovereign digital identities, Blockchain has introduced a trust model that many believe can surpass the capabilities of paper-based identity management.

3.2.2. Online Identity

Online identity has traditionally been viewed through the lens of an organisation, therefore it is not surprising that the focus has been on the organisational needs and not needs of the individual (Swan, 2015). Organisations become identity providers (IDPs) by providing individuals with “identifier” data, unique attributes used to access their system (McWaters, 2016). The result of this is that people end up with hundreds of online identities from different organisations, and the identities are lawfully owned by the proprietors of the organisations (Swan, 2015). This problem has consequently led to the concept of self-sovereign identities, which can now be achieved using Blockchain. For the first time in history, in as much as Blockchain affords, the possibility of individuals owning their identity is achievable. These and other common business cases are discussed in forthcoming sections.

3.2.3. Digital Evolution

It is important to understand the context of humanity’s digital evolution to appreciate and understand how blockchain can have an impact on the world.

Blockchain has unlocked a new era of digital evolution (Lewis, 2016) that transforms the internet of information to the internet of value (Maverick, 2017). This era is powered by a combination of mathematics, cryptography, software engineering and behavioural economics (Tapscott & Tapscott, 2017). The technology promises to introduce new business models and disrupt industries (Swan, 2015) because it challenges how societies have been structured, how participation has been rewarded and how value has been defined (Tapscott & Tapscott, 2017). All of this contributes to the continuous advancements of IT in all human endeavours.

3.2.4. The Categories of Blockchain

The disruptive technology can be grouped into three categories: identified as Blockchain 1.0, 2.0 and 3.0 (Swan, 2015). An example of Blockchain 1.0 is currency; applications that leverage off Blockchain in relation to cash; the transfer or currency; remittances and payment systems. Blockchain 2.0 is the establishment of contracts; the entire slate of financial, economic applications using Blockchain for extensive transactions i.e. stocks, bonds, loans, mortgages, titles, property. Blockchain 3.0 refers to applications in the areas of government, health, science, culture and art.

These advancements of the technology are gradually causing a shift computing paradigm in the world (Swan,2015).

3.2.5. The Fifth Disruptive Computing Paradigm

The history of computing paradigms consists of innovations such as main frame; personal computing; the internet; mobile; social networking and cloud computing. These paradigm shifts have ultimately led to the connected world we live in today. Computing that relies on Blockchain cryptography can be considered as the most current emerging paradigm because, like the internet, it has changed the way individuals and organisations approach problems (Swan, 2015). From selecting appropriate IT infrastructures, to establishing distributed networks, understanding cost implications and regulation of data transferred on Blockchains (Tapscott & Tapscott, 2017). Blockchain conveniently fits into the connected world of multidevice computing, but it brings with its possibilities that motivate diverse approaches to problem solving (Swan,2015). Given the widespread global network effect, Blockchain could be adopted much quicker than the internet was (Swan, 2015).

3.3. Blockchain 1.0

Essentially Blockchain 1.0 is currency, originally it began as Bitcoin. This initial version of Blockchain encompasses the deployment of cryptocurrencies in applications related to cash, such as money transfer, remittance, and digital payment systems (Swan, 2015).

The three layers of Bitcoin are the general structure for cryptocurrencies: Blockchain, protocol and the currency. Figure 3.1 illustrates the layers of Bitcoin in relation to the Internet Protocol (Syme & Goldie, 2004). These layers are described as follows:

- The application Layer – ensures effective and direct interaction with the end user.
- The application protocol Layer – defines how application processes that run on different end systems pass messages to each other.

- General Protocol Layer – Also known as the Transport Layer, provide host-to-host communication services for applications.

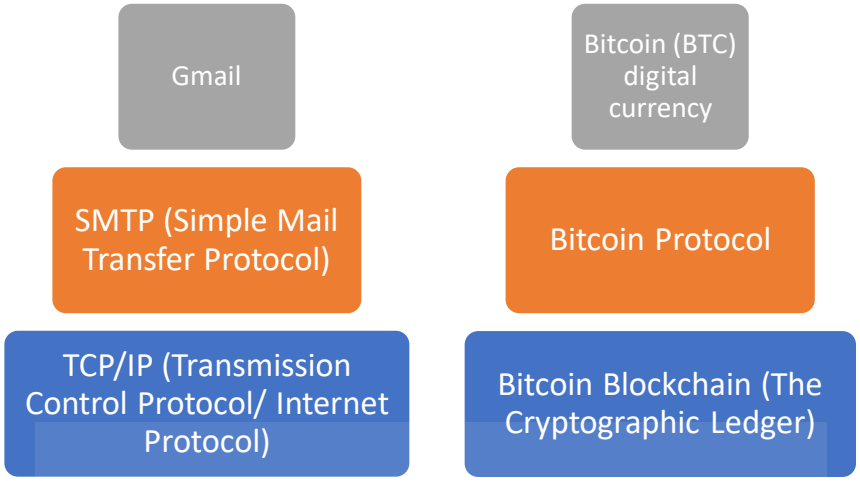


Figure 3.1: Layers of Bitcoin in Relation to Internet Protocols

Traditionally, an exchange of digital money would require that a trusted third party keeps a ledger containing all transactions and ensures that transactions had occurred only once (Swan, 2015). Blockchain solves this third-party problem by combining BitTorrent peer-to-peer file sharing with public key cryptography, thereby preventing the digital money from being spent more than once. To achieve this, the ownership of a coin is confirmed by cryptographic protocols and the mining community.

3.3.1. Bitcoin Cryptographic Protocols

The key part of blockchain technology is the way in which cryptographic techniques are applied. If one takes the Bitcoin public key cryptography for example; each Bitcoin contains a public key that is linked to its current owner (Figure 3.2).

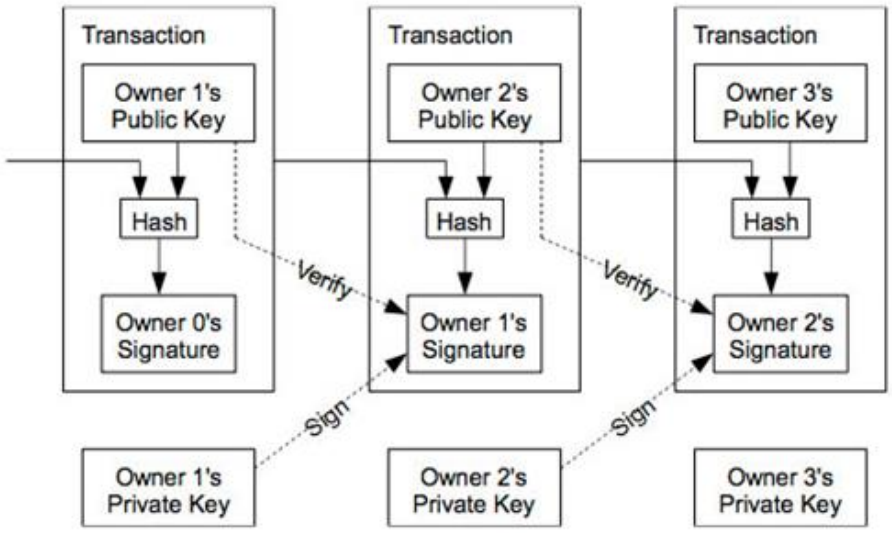


Diagram of a Bitcoin
from *Bitcoin: A Peer-to-Peer Electronic Cash System*,
published in 2008 by "Satoshi Nakamoto".

Figure 3.2: Process flow of a Bitcoin Transaction

When a transaction takes place the receiver's public key is attached to the transaction and the transaction is signed with the sender's private key. When this transaction is broadcasted on the Bitcoin Blockchain, the network is informed that the new owner has become the owner of the public key. The sender's signature on the transaction verifies that the message is authentic. A complete history of all transactions is kept on the Blockchain (Lewis, 2016).

Each block in the series of blocks contains a group of transactions that took place after the last transaction in the previous block. To preserve the integrity of the chain, each block validates the integrity of the previous block, this goes back as far as the genesis block (the original block). The process involves a lot more detail of the functions used to authenticate transactions. The above explanation is only a high-level technical overview of the transaction process.

Bitcoin and other alternative coins, known as Altcoins, constitute as Blockchain 1.0 (Swan,2015) public Blockchains that are always open, distributed (Tapscott & Tapscott, 2017). The protocol requires proof-of-work, an algorithm that is used to confirm transactions and produce new blocks to the chain (Tar, 2018). However, Blockchain 1.0 is being extended to Blockchain 2.0, which features a more robust

functionality of programmable transactions (Swan, 2015). This will be covered in section 3.4.

3.3.2. Regulatory Status of Blockchain 1.0 (Cryptocurrencies)

Government regulation is perhaps one of the most substantial factors that determines whether Blockchain 1.0 will advance into an established financial services industry.

Globally, various communities and governments amid economic crisis have adopted cryptocurrencies as an attempt to combat hyperinflation (Windley, & Smolenski, 2018). Some of these nations affected by the cryptocurrency movements include Zimbabwe, Greece, Venezuela (Otis, Vivek, Reuters, D'Alfonso, & Langer, 2016). Moreover, economically stable countries like Canada and the US have advocated for Blockchain 1.0 and taken steps to promote cryptocurrencies to create parity for virtual currencies (Thomson Reuters, 2017). In 2017, Canada gave the approval to Impak Coin which became the first Canadian approved cryptocurrency (Bloomberg, 2017).

On the other end of the spectrum nations like China, Bangladesh and Bolivia have placed complete bans on cryptocurrencies (Thomson Reuters, 2017). Bangladesh threatens punitive sanctions on individuals caught with them (Thomson Reuters, 2017). China outlawed the use of cryptocurrencies in 2017, which resulted in the crypto market losing almost 50% of its value (Weese, 2017).

In South Africa, the South African Revenue Service (SARS) deemed all cryptocurrencies taxable and stated that they will be regarded as assets of an intangible nature (SARS, 2018).

3.4. Blockchain 2.0

Blockchain 2.0 is the next big tier in the development of the Blockchain industry (Swan, 2015). There are many different categories and considerations of Blockchain 2.0, but standards and definitions are continuing to emerge. Whereas Blockchain 1.0 is for the transfer of cryptocurrencies, Blockchain 2.0 is for the transfer of assets beyond currency, from the creation of a unit value. Much of what is transferred on Blockchain includes smart contracts, smart property. This leads to the decentralisation of markets. The most prominent form of Blockchain 2.0 is Ethereum.

Ethereum introduced the concept of smart contracts, or decentralised autonomous organisations (DAOs), which has become a leading topic of discussion in the Blockchain industry (Agrawal, Van der Veer, Kirk, & Arnab, 2017).

Essentially, smart contracts are autonomous programs that are executed when pre-defined conditions are met. The great advantage of smart contracts is that they are impossible to hack, thereby reducing the costs of verifications, arbitration and fraud (Swan, 2015). In the same way that Blockchain 1.0 solved the double spend problem, Blockchain 2.0 solves the moral hazard problem (Guerra Guerra, 2018). The Moral hazard problem is common in financial markets. It is defined as a situation in which an individual or group takes a risk knowing they are protected because another party will incur the cost (Thompson, 2008).

3.4.1. Smart contracts

In 1994, a cryptographer and legal theorist Szabo came up with the concept of self-executing contracts on a decentralised ledger (Rosic, 2016). In this format, contracts could be converted to code and stored on the Blockchain. However, Szabo's notion of smart contracts did not find usage until cryptocurrencies came into play in 2008. Now that Blockchain and smart contracts can be used together, it is conceivable to trigger payments when a predefined condition of a contract agreement has been reached. This also results in automatic feedback on the ledger that includes confirmation of goods received or services rendered (Swan, 2015). More so, smart contracts not only define the rules and penalties around an agreement but also automatically enforce those obligations (Rosic, 2016). Ethereum and Codius are platforms that have successfully enabled smart contracts on Blockchain (Crosby et al., 2015).

3.4.2. Ethereum

Ethereum is a Turing-complete virtual machine that can run any cryptocurrency, coin or script (Swan, 2015). Rather than a universal development platform, Ethereum is an underlying infrastructure that can run all Blockchains and protocols (Ethereum, 2016). Each node on the Ethereum network runs the Ethereum virtual machine for the execution of smart contracts (Meredith, 2015).

The Ethereum ecosystem consists of three components namely; Swarm, Whisper and Reputation (Ethereum, 2016). These components serve for file serving, messages and vouching of reputation (Swan, 2015) as shown below:

- Swarm: is as a decentralised file-serving method on the Ethereum network.
- Whisper: is a peer-to-peer protocol for secret messaging and digital cryptography.
- Reputation: a way to establish reputation and reduce risk between agents in trust-less networks.

Over time, contracts that are executed on platforms like Ethereum could become extremely complex and autonomous (Swan, 2015). Although many experimental projects have risen from Blockchain 2.0, it may take some years for Blockchain 2.0 and 3.0 to create real economic impacts (Zhao, Fan, & Yan, 2016). Table 3.1 depicts the differences between Blockchain 1.0 and Blockchain 2.0 and the benefits of the latter.

Table 3.1: Differences between Blockchain 1.0 and 2.0

Blockchain 1.0	**Blockchain 2.0**	**Benefits of Blockchain 2.0**
Bitcoin Blockchain	Ethereum, Corda, Hyperledger	Not locked into one vendor
Simple Transactions	Generic Contracts	Can lever more complex requests
One Blockchain	Multiple Linked Blockchains	Can partition information to suit needs
Public chains	Public, Private, Consortium, Domain specific.	Solves privacy and regulatory requirements
Proof of Work only	Proof of stake, identity etc.	Overcomes speed issues and computational costs.
Always Open and Distributed	User choice	Can tailor solutions around business needs.

3.5. Blockchain 3.0

As demonstrated by Ethereum and Bitcoin, Blockchain technology affords people a universal scope and scale that was previously impossible. This is particularly evident in the allocation of resources (Swan, 2015). The technology facilitates the automated resource allocation for tangible and intangible assets. It also facilitates manners of human interaction and paves the way for interaction between humans and machines (Lewis, 2016).

Blockchain 3.0 is expected to improve the capabilities of platforms like Ethereum and Bitcoin while overcoming their observed limitations (Narayanan, 2015). At the time of writing this chapter, Blockchain 3.0 is mostly a theoretical concept and has not been extensively adopted in the global IT infrastructure (Swan, 2015). However, scientist and researchers (Kane, 2017; Swan, 2016; Crosby et al., 2015) believe it to be a complete diffusion of the technology throughout society, potentially disrupting systems of identification and government services (Kane, 2017). Blockchain 3.0 moves into fields of justice, the arts, health and education.

Figure 3.3 displays findings of a study conducted on 200 contemporary Blockchain applications at RMIT University (Kane, 2017). This reveals the number of applications that fall into the different categories of Blockchain (Kane, 2017). Most applications fall into the second category.

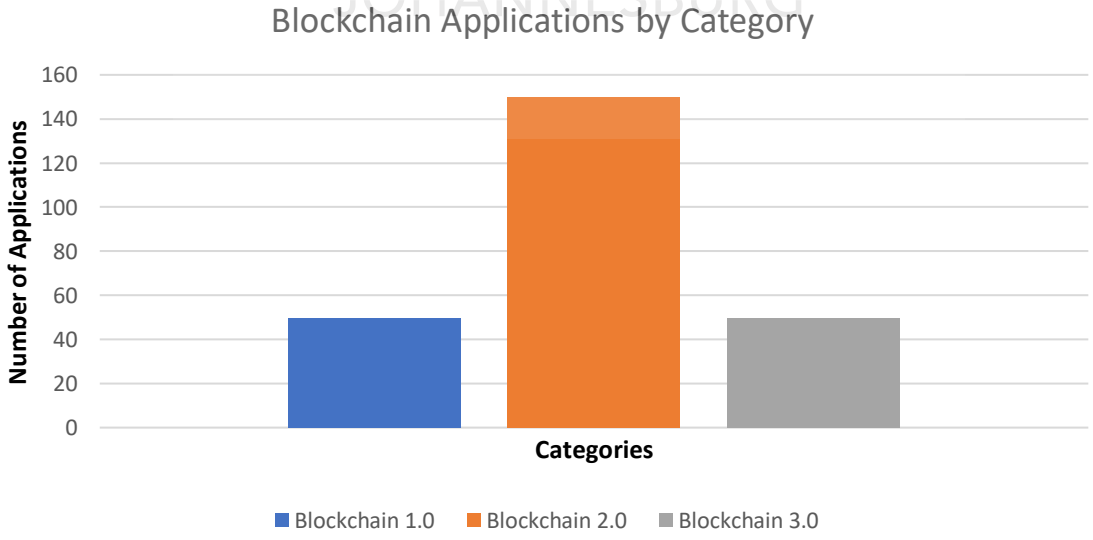


Figure 3.3: Research on Blockchain application types

To contemplate how Blockchain might affect disciplines like corporate governance, one can explore Blockchain 3.0. A notable project that exhibits the concept of Blockchain 3.0 is a project called the Folding@Home Project (Stanford University 2016).

This Blockchain application uses computing cycles to simulate protein folding for computational drug designs and molecular dynamic problems (Swan, 2015). This project provides a counterparty token, Folding Coin, that runs on the platform and is exchangeable to cryptocurrencies like Bitcoin and regular fiat currencies (Ross, 2017). The Folding Project has turned into a vibrant community of miners that mine for medical research rather than to crack algorithmic hashes (Swan, 2015). The efforts of miners can contribute to finding cures for cancer and other diseases.

Without Blockchain technology, researchers must spend hefty amounts on supercomputers to execute molecular simulations (Ross, 2017). This project allows anyone to download the FoldingCoin framework and run the program on their computer. This therefore distributes the work load to a trusted network of individuals on the Blockchain.

A more essential use of Blockchain 3.0 would be to address the excessive energy consumption resulting from the mining of coins. Instead of using computing power to crunch arbitrary numbers, perhaps the processing power of mining could be applied to solve more practical tasks and real-world problems (Swan, 2015).

3.5.1. Name Coin Project

Namecoin is one of the first non-currency uses of Blockchain (Swan, 2015). It exhibits the concept of Blockchain 3.0 in the form of preventing internet censorship. This coin was created to verify domain name registrations (Kalodner, Carlsten, Ellenbogen, Bonneau, & Narayanan, 2015). It provides an alternative for the traditional Domain Name Servers (DNS) that are central to the internet. The advantages of a decentralised DNS are that it is transnational and not controlled by any single entity, thereby making it possible for individuals around the world to publish information freely.

Namecoin was the first Blockchain solution to solve the long-standing problem of producing a naming system that is secure, decentralised and meaningful. This problem is known as the Zooko's Triangle, a trilemma of three desirable naming properties for participants on a network. Namecoin is an example of Blockchain 3.0 that highlights the issue of the appropriate administration of transnational public assets and presented a solution for managing it (Swan, 2015). Namecoin provides a free speech mechanism for domains that might be censored, for instance in countries with limited political freedom.

3.6. Discussion

Exploring Blockchain in theory only paints half of the bigger picture. It is only in connecting the dots that one can begin to understand its global impact. This section discusses examples of traditional human and computing activities that are evolving with the use of Blockchain.

All human societies have a trust problem (Danaher, 2015). It is widely understood that all human activities, such as running a business, maintaining a relationship or making a living requires co-ordination and cooperation with others (Swan, 2015). However, there is and always has been the potential to mislead and abuse the trust of co-operating parties in any agreement. To address this problem of trust, several societies have invented intermediaries such as central banks, government, rituals and laws (Danaher, 2015).

The distributed consensus method that Blockchain provides eradicates the need for intermediaries entirely (Swan, 2015). This means that societies could ultimately become reliant on the technology as a trust mechanism.

In business, firms are looking for existing platforms that allow them to launch their products (Satell, 2016). The emphasis is moving from developing new applications to developing platforms, or "protocols" that can be adopted as needed. Currently, there are over a thousand Decentralised applications (DApps) running on the Ethereum network (Ethereum, 2018).

Ethereum is an example of a Platforms as a Service (PaaS). Outside of Blockchain, PaaS offerings have been commonly released by large enterprises such as Google,

Microsoft or Amazon. Blockchain allows individuals and smaller organisations to develop their own PaaS. This has a tremendous effect on the power dynamics and competition in the IT industry.

As demonstrated in the example of Folding Project, Blockchain enables any individual with a computer and internet access to take part in a transparent large scale and self-organised group effort. Crowdfunding on Blockchain, ICO's and collaborative computing are drawing immense attention as they provide transparent and secure ways of collective contribution. The system is protected against hacking attacks and fraud because there is no central point which can be exploited.

3.7. Conclusion

This literature review has highlighted the possibilities of Blockchain by exploring its history, the different versions and how each version has been and can be applied in modern societies. Since this industry is relatively new, further research will inevitably emerge. The review has demonstrated how cryptocurrencies are affecting technology, finance and banking in an unprecedented way. This was highlighted in the emergence of smart contracts and how they are beginning to reshape our understanding of trust and exchange. This chapter then looked at Blockchain 3.0 and how it could provide justice applications that go beyond currency, economics and markets.

The process of organizing any form of activity through a distributed network can reinvent many categories of human endeavours, be it in politics, economy, health-care or science. Blockchain is proving to be the fifth disruptive computing paradigm shift (Swan, 2015).

The purpose of this chapter was to discuss and explain Blockchain and its use cases. This provides the high-level context and background required to understand and appreciate the chapters that will follow.

4. Chapter 4 – Research Methodology and Design

4.1. Introduction

This chapter explores research methodologies, philosophies, approaches, assumptions and techniques. All of these elements are used to derive the hypothesis that Blockchain technology may lead to the disruption of conventional ITG processes.

4.1.1. Background

Many scholars have described research design as a systematic study performed to gain new insight or knowledge on a given subject matter (Saunders, Lewis, & Thornhill, 2009). Research designs often need to undergo multiple alterations as the study progresses and insights deepen. As a result, researchers end up with designs that are unique and an extension of their own methodological strategies (Singh & Nayak, 2015).

In many cases, there is little attention paid to an important dimension of research, the methodology. The result of an unfitting methodology can be endless word spinning and quotations. The significance of research lies in its quality and not quantity (Pandey & Pandey, 2015).

It is therefore important to exhaust the research planning to conduct the research efficiently and reap valuable insight.

4.1.2. Chapter Layout

The first section introduces the research design framework from which this design is guided, the framework known as the research onion. The next section probes qualitative and quantitative research methods. The third section explores research philosophies and highlights the selected research design. The research approaches and strategies are examined and selected. The fifth section briefly discusses time horizons and indicates the selected one. The last section focuses on data collection techniques and analysis.

4.2. The Research Onion

The research approach for the dissertation follows the Research Onion progressive framework (Figure 4.1) that was developed by Saunders (2007). Each layer in this figure represents stages of a research process. It provides an effective way of designing and progressing through a research methodology. This is done from the outer layers and moves into the inner layers, like peeling an onion, hence the name research onion.

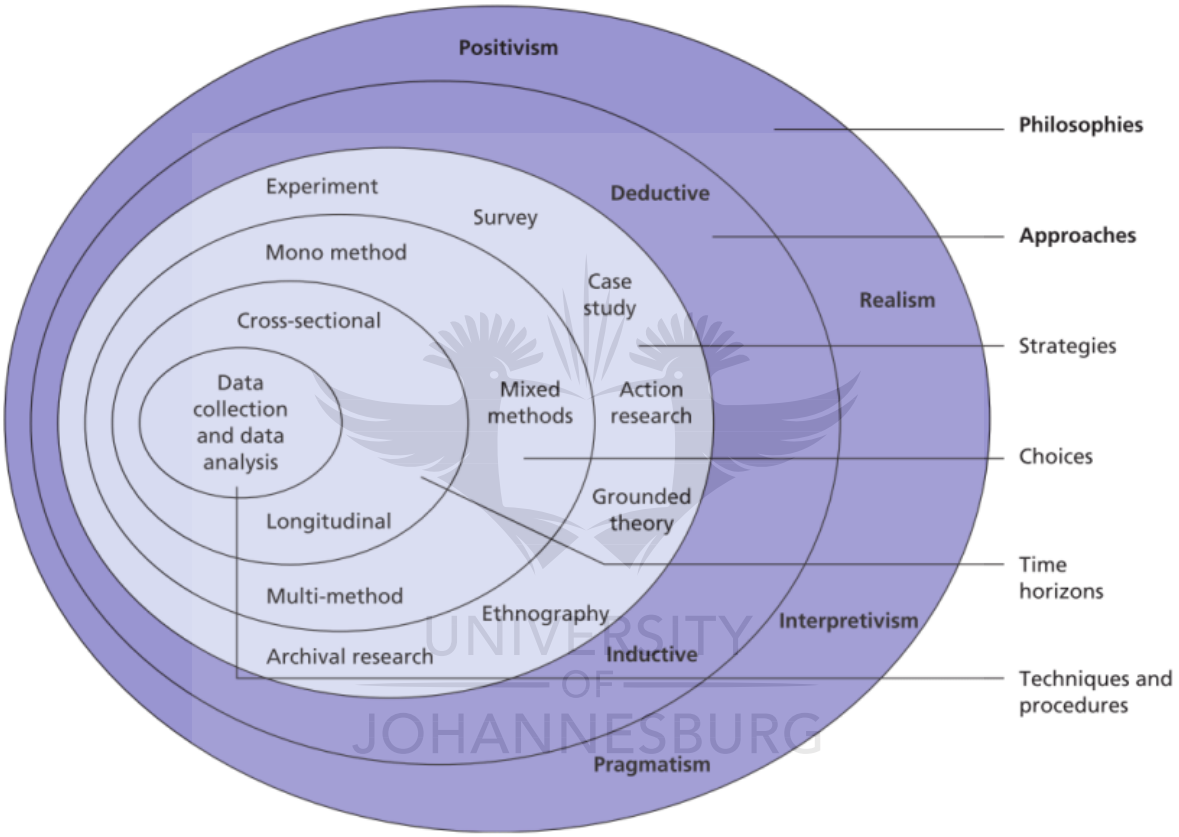


Figure 4.1: The Research Onion. Saunders (2009)

4.3. Research Methods

Research methods are categorised by the purpose and nature of the study. Research methods can be broadly divided into two, namely quantitative and qualitative categories (Dudovskiy, 2011). This section will describe these two research methods.

4.3.1. Quantitative Research

In quantitative research, the emphasis is placed on the collection of numerical or quantifiable data that verifiably substantiates a theory (Pandey & Pandey, 2015). In this research method, objective measurements and statistical analysis of data is done through techniques like questionnaires, polls or by using existing statistical data (LeCompte & Schensul, 1999). The focus of this method of research is to gather quantifiable numerical data and generalise it to explain a phenomenon.

The goal of quantitative research is to determine the relationships between an independent variable and a dependent variable (Babbie, 2018) within a population. Quantitative research designs can be experimental or descriptive. Experimental studies deal with causality. This involves measuring subjects prior and post an experiment. Descriptive studies establish the associations between different variables.

The main goal in quantitative research is to classify features, count them and develop verifiable models then logically explain what is observed (Babbie, 2018).

4.3.2. Qualitative Research

Qualitative research is characterised by its aims to understand some aspect of social life (Patton & Cochran, A Guide to Using Qualitative Research Methodology, 2002). Qualitative research methods are more concerned with gaining insights with an emphasis on underlying reasons and motivations (Dudovskiy, 2011). Many scholars have argued that, qualitative research is best used on topics or situations where there is minimal quantitative data available (Patton, & Cochran, 2002; Dudovskiy, 2011; Singh, 2011). The objective is to understand the experiences and attitudes of research subjects.

Qualitative methods come with the acknowledgement of abstraction and generalisation (Dudovskiy, 2011). Waller and Polonsky (2011) group the appropriate data collection methods for qualitative research by vision, forms, images, spoken and written word and recorded sound.

It is important to understand the qualitative methods provide rich data about lived experiences and observable environments. This allows researchers to understand

behaviours, abstract notions and get a wider context of their research topic (Dudovskiy, 2011).

Despite providing in-depth understanding, qualitative research has been criticised for lacking objectivity, reliability or decisiveness. However, it also facilitates conceptualisation that is often required for complex disciplines and social studies. Numerous studies have suggested that in some areas like concept development, idea evaluation, portfolio planning and strategy and policy-making, qualitative research is the prime source of research (Cooper & Patterson, 2013).

Popular qualitative data collection methods used in business studies include interviews, focus groups, observation and action research (Dudovskiy, 2011).

Although many qualitative studies have been regarded as non-scientific, its methods are still a respectable science because it involves systemic protocols that should be followed to support sound arguments (Singh & Nayak, 2015). In qualitative research, it is important to show context, credibility and intellectual integrity, these are described below:

I. Context

A cardinal principle of a research approach is to keep the hypothesis in context. This is due to the fact that results, methods and conclusions are dependent on context (Singh & Nayak, 2015). Therefore, it is significant that the context is carefully referenced (Creswell, 1997). This can be done by providing detailed background information, such as the types of people involved in the research, the time period, environment and the reasons why the data collected is applicable to the theory.

II. Credibility

Credibility is defined as the confidence that can be placed in the truth of the research findings (Holloway & Wheeler, 2002; Macnee & McCabe, 2008). Credibility proves that research findings embody plausible information drawn from the participants' original data and is a correct interpretation of the participants' original views (Lincoln & Guba, 1985; Graneheim & Lundman, 2004).

To strengthen credibility, it is essential that qualitative research includes information about the researcher that could lead to interpretive bias or affect data collection or

analysis of the research. For example, information relating to personal connections that the researcher has with participants, the topic or situation and context (Cooper & Patterson, 2013). The researcher should maintain consistency as they analyse the information collected. When a researcher returns to the data collected, they should ensure that the themes, constructs and interpretations make sense and reflect the nature of the phenomenon (Emma Eccles Jones Research Center, 2018).

Credibility requires the researcher to perform the following three activities:

i. Prolonged engagement

   To become familiar with the topic the researcher must spend sufficient time on the topic and explore and understand all aspects of the context in order to properly identify factors that influence the phenomenon. Prolonged engagement is also necessary to build rapport with participants in the research.

ii. Persistent observation

   The researcher needs to be able to recognise and focus on relevant characteristics of the context of study. Observation should be continuous until the researcher reaches a point of saturation to retrieve as much authentic data as possible.

iii. Triangulation

   Triangulation is a research strategy for reducing systematic bias (Emma Eccles Jones Research Center, 2018). It refers to the use of multiple diverse data sources to develop a comprehensive understanding of phenomena (Patton, Enhancing the quality and credibility of qualitative analysis, 1999). The process of triangulation ensures that the research is an unbiased and consists of multiple examples and sources of information. Denzin (1978) and Patton (1999) identified four types of triangulation: (a) method triangulation, (b) investigator triangulation, (c) theory triangulation, and (d) data source triangulation (Carter et al., 2014).

III. Intellectual Integrity

To maintain intellectual integrity, it is vital to search for opposing cases or evidence that contradicts patterns of the general research findings (Emma Eccles Jones Research Center, 2018). This can be done by including alternative explanations or reasoning for opposing data. To challenge biases, a research can document their perspective and allow sceptical and critical thinking to consider other perspectives. Additionally, following up with participants may be necessary for clarifications down the line (Dudovskiy, 2011). The key factor in maintaining intellectual integrity is to be educated on the different research approaches. This ensures the researcher can make informed decisions and design a more rigorous study.

4.4. Research Philosophy

Research philosophy is the basic belief system or world view that guides an investigation (Guba & Lincoln, 1994). The term philosophy in research refers to the development of knowledge and the nature of that knowledge (Datt, 2016).

The philosophy behind academic research reveals the source, nature and development of knowledge. This development of knowledge is formed from assumptions made from one's perspective of the world (Gialdino, 2009). Based on different perspectives, strategies and methods for different research will always differ (Creswell, 1997).

To substantiate the way data in this research will be elicited, gathered and analysed, three different belief paradigms are explored, namely: ontology, axiology and epistemology. Each of these ways of thinking influence the way one thinks about a research process. The purpose of highlighting these thinking preferences is not to argue which is the best approach but to understand one approach in relation to another and to determine how the selected one is most suitable for this research.

4.4.1. Ontology

The ontological philosophy is concerned with that which constitutes reality. It focuses on objective questions that relate to matters that exist in the real world. Matters that fall outside of this realm, for example moral significance and aesthetics are deemed insignificant (Kothari, 2004).

In the context of Blockchain technology, ontology would treat the questions of existence. For example; what is Blockchain technology? How is it being characterised, created, and implemented? In a practical point of view, it would provide a concise definition of the technology (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017).

4.4.2. Axiology

Axiology is concerned with the assessment of the researcher's values in all phases of the research (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017). This philosophy primarily focuses on two aspects - subjectivism and objectivism. Subjectivism embraces that social phenomena are formed based on the perceptions and actions of the social actors involved. Objectivism portrays that social entities exist outside of social actors involved. In the context of Blockchain, an axiology philosophy would focus on how Blockchain technology is valorised, taken up, and regarded by individuals and society (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017).

4.4.3. Epistemology

The term epistemology refers to what is known to be true, as opposed to doxology; what is believed to be true (Singh & Nayak, 2015). The assumptions in epistemology are concerned with how knowledge can be formed, disseminated and communicated (Datt, 2016). It focuses on what is means to know. Epistemology asks the question, what is the nature of the relationship between the researcher and what can be known (Guba & Lincoln, 1994).

In the context of Blockchain technology, an epistemological approach would ask what new kinds of things Blockchain technology is helping us to know or understand (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017).

With regards to new knowledge and new ways of knowing, the researcher could ask about the corresponding standards of proof, or truth, that supports this new knowledge. For example, is there new knowledge that is required to create and engage with Blockchain technology (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017).

Based on the main objectives of this dissertation, the selected philosophy is epistemology. The problem statement is to identify how principles of Blockchain technology may affect ITG disciplines and to highlight how the scope of governance frameworks have limitations. Epistemology is most suitable for this research because it addresses questions such as:

- What is knowledge? For the purposes of this study, what is ITG?
- How is this knowledge acquired? – This can be ascertained by interviewing subject matter experts.
- What do people know? – How much of what exists in ITG frameworks include the concept of distributed ledgers and decentralised business models?
- How do we know what we know? – How can we make informed decisions using governance frameworks that do not include concepts of DLTs[1] , DApps[2] and market decentralisation? How can we measure good ITG in the context of today's disruptive technologies?

The assumptions based on each of the above-mentioned philosophies can be fragmented and guided by different elements. Three major intrinsic elements of epistemology are positivism, interpretivism and realism. These are described below:

I. Positivism

The principle of positivism supports working with observable social reality. The product of positivism is often law-like generalisations like those produced by physical and natural scientists (Remenyi, 2008). Positivism requires that a research makes use of existing theories to develop a hypothesis. The hypothesis is then tested and confirmed which may lead to further progress of the theory. The driving notion of positivism is that only observable phenomena will lead to the production of credible data.

II. Interpretivism

Interpretivism advocates the understanding of differences or similarities between humans in their roles as social actors (Singh & Nayak, 2015). Contrasting positivism,

[1] Distributed Ledger Technology
[2] Decentralised Applications

this principle negates that rich insights into complex problems can be formed solely from law like generalisations (Saunders et al., 2009). The notion of interpretivism is based on how one interprets social roles in accordance with the meaning one gives to these roles. Additionally, the roles may be interpreted in accordance with a subjective frame of reference (Datt, 2016).

Often a qualitative approach is applied that promotes interaction with individuals in order to collaboratively construct a meaningful reality (Rowlands, 2005).

III. Realism

Realism refers to scientific inquiry emphasising on the reality projected by one's sense as truth (Datt, 2016). This philosophy depends on the idea of independence of reality from the human mind, it can be divided into two groups; direct and critical realism.

Direct realism is the belief that what one observes and perceives through one's human senses is real (Gram, 1983). In contrast, critical realism is the belief that what one observes are only images of objects and not the actual objects.

IV. Pragmatism

The philosophy of pragmatism accepts ideas if they support actions. The concept recognises that there are a multitude of ways to interpret and understand the world and that no single view can summarise the entire picture. Pragmatism supports multiple realities and denotes that research questions are the most significant factor of the philosophy. Table 4.1 highlights the selected approach for this research.

Table 4.1: Data collection Methods for Philosophical Principles

	Interpretivism	Pragmatism	Realism	Positivism
Description	Interpret social roles in accordance with unique frames of reference.	Accepts ideas to be substantial only if they support actions.	Scientific inquiry focused on projected reality. Includes two groups:	Working with observable social reality.

			Direct realism Critical realism.	
Common Methodologies	Mixed or multiple method designs, quantitative and qualitative	Highly structured, large samples, Measurement, quantitative, but can use qualitative	Methods chosen must fit the subject matter, quantitative or qualitative.	Small samples, in-depth investigations, qualitative

The selected philosophical method for this research is interpretivism. The study interprets the role of IT Directors in DAOs in accordance with the COBIT's Enterprise ITG guidelines.

4.5. Research Approach

The research approach is a plan that consists of steps and procedures to complete the research (Dudovskiy, 2011). These procedures span from broad assumptions to detailed methods of data collection, analysis, and interpretation (Creswell, 2012).

Deductive Approach

Deductive reasoning is one of the two basic types of logical inference (Johnson-Laird, 2009). Researchers practise deduction when making connections from a premise to a conclusion.

According to Goldstein (2007), the Greek philosopher Aristotle was considered to be the father of deductive reasoning, who simplified it into the following classic example:

- All men are mortal.
- Socrates is a man.

- Therefore, Socrates is mortal.

The premise established in this example is that Socrates is a member of a group of individuals whom are all mortal. The apparent conclusion is that Socrates must be mortal.

In deductive research, the objective is to test concepts from existing theories by using new empirical data. This approach is known as theory-testing (Singh & Nayak, 2015) or top-down logic (Soiferman, 2010). Nevertheless, the goal of deductive research is not always to test a theory, this approach can be used to expand on or improve an existing theory (Datt, 2016). Deductive is most suitable when there are existing competing theories on a phenomenon and research examine the best theories under certain circumstance.

Studies that use deduction as an approach follow the following sequential steps (Robson, 2002):

i. Deducing hypothesis: this first step involves creating a proposition that can be tested. The proposition involves the relationship between two or more concepts.
ii. Formulating a hypothesis in operational terms: Indicating how concepts or variables are to be measured.
iii. Testing hypothesis.
iv. Examining the outcome of the theory and inquiry.
v. Modifying the theory: If necessary, this step involves adjusting the theory in light of the research finding.

Once these steps have been followed, it is essential to verify the revised theory by restarting or repeating the cycle.

The risk of deductive approach is syllogism, an instance of a form of reasoning where a conclusion is drawn from two premises. Both premises can include a common term but is not the conclusion.

Deductive arguments are not referred to as true or false, but rather as sound or unsound. In a sound argument, the premise guarantees the conclusions, in contracts

and unsound argument, the premise does not guarantee the conclusion. This means that a deduction can be true and unsound or sound and untrue.

The advantage of deductive reasoning is that there is a possibility to explain casual relationships between concepts and variables (Dudovskiy, 2011).

4.5.2. Inductive Approach

In inductive research, the objective is to infer theories and patterns from observable data. This approach is known as theory-building (Singh & Nayak, 2015).

To successfully examine the impact of a modern technology, an inductive approach is the best approach because it focuses on building a theory where there are few prior theories or explanations of this subject matter. However deductive reasoning will be applied to aspects of the research that have already been conceptualised and written in theory, such as ITG processes.

Inductive and deductive approaches go hand in hand when building a theoretical model (Singh & Nayak, 2015), therefore researchers should be able to go back and forth on inductive and deductive reasoning if they are aiming to improve or modify an existing theory or develop an enhanced one.

Inductive reasoning begins with detailed observations of the world (Figure 4.2), this then moves towards more abstract generalisations and concepts (Dudovskiy, 2011). Unlike deductive reasoning, induction does not use syllogisms, but a series of observations, in order to reach a conclusion. The observations begin with a general principle, then a chain of evidence is added and combined with previous observations.

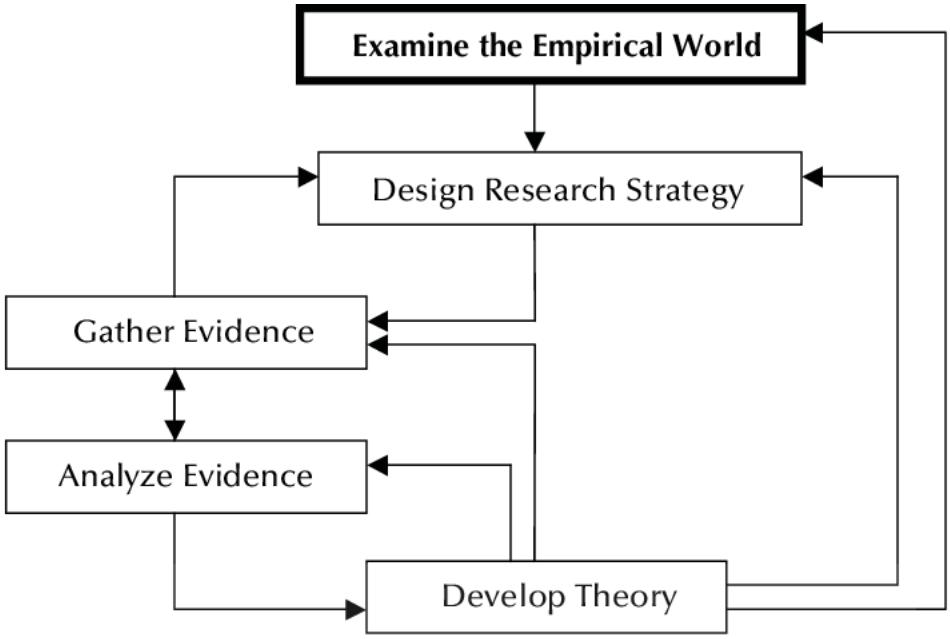


Figure 4.2: Inductive Reasoning Process

It must be noted that inductive research disregards existing theories when forming research questions or ideas. Induction aims to create meaning from data collected as a way to identify patterns and relationships to build a theory (Datt, 2016). This approach is based on learning from experience. Therefore patterns, standards and common premises are observed to reach a conclusion.

When following an inductive approach, the researcher begins with a topic and builds an empirical generalisation and finds relationships in the process (Kothari, 2004) . In the initial stage, if no hypothesis can be found, this means the researcher will confirm their proposed theory based on their findings when the study is complete.

One of the risks of inductive research is hasty generalisations (Pandey & Pandey, 2015). Fallacies can occur when researchers commit an early inductive leap or make an induction that is not based on sufficient evidence to substantiate a claim.

The correctness of theories for inductive reasoning is more flexible than deduction (Soiferman, 2010). An argument based on inductive research is deemed correct when the premise provides legitimate evidence or supports the truth of the conclusion (Singh & Nayak, 2015). However, it should be noted that no inductive argument is absolutely perfect or entirely impractical, although some may be relatively better or worse than

others because they propose a more probable conclusion. In every case, relevant information strengthens the reliability of an inductive argument (Datt, 2016).

Inductive research often deals with unique contexts in which events take place (Creswell, 1997). Therefore, the research can be conducted from a small sample of subjects as opposed to a substantial number, as with the deductive approach (Singh & Nayak, 2015).

Another important characteristic of inductive research is that it is most appropriate for studies that have a shortage of literature to develop a hypothesis. There seems to be a dearth in scholarly literature on existing frameworks or theories on the impact of Blockchain technology on ITG. Therefore, an inductive approach is best suited for this study. Table 4.2 summarises the difference between inductive and deductive and shows the one selected.

Table 4.2: Differences between Inductive and Deductive Approaches

Deductive	Inductive
Begins with scientific principles	Focus is on understanding meaning
Converting theory to quantifiable data	A close understanding of the research context
Focuses on causality between different variables.	Focuses on relationships between variables
Mostly uses quantitative data.	Mostly uses qualitative data
Uses control measures to validate data	Requires Credibility and context to create correctness.
Approach is highly structured	Structure is flexible to permit changes of research emphasis
The research must employ objectivity	Researcher is part of the research process, which may lead to subjectivity.
A sample of sufficient size is required in order to form generalizations.	No need to generalise

4.6. Research Strategies

It must be emphasised that no single strategy is more superior to the other. The importance lies in being able to address a problem statement or answer a particular research question to meet the objectives of the overall study.

The research questions, objectives, existing knowledge, time and other available resources and the philosophical underpinnings should guide the selected research strategy (Saunders et al., 2009). However, these strategies ought not to be considered as being mutually exclusive. The strategies that are discussed in this section are; survey; case study; grounded theory; ethnography and archival research.

4.6.1. Survey

Survey research is defined as the collection of information from a sample of individuals through their responses to questions (Check & Schutt, 2012). It is a well-known and

common system in business and management research (Dudovskiy, 2011) and is oftentimes used to answer who, what, where, how much and what number of inquiries. It consequently tends to be used for exploratory and descriptive research (Chambliss & Schutt, 2014).

The essence of surveying is to question individuals on topics and describe their answers (Dudovskiy, 2011). Surveys can be used as the primary data collection method to test concepts, reflect attitudes and opinions of participants or to conduct market research. Surveys can be used both in quantitative and qualitative studies. Its two main purposes are to describe characteristics of the population or test a hypothesis (Dudovskiy, 2011).

The data collected from participants during a survey can be used to formulate hypotheses or validate an existing one (Singh & Nayak, 2015). It can highlight relationships between variables. The survey method gives researchers more control over the examination procedure and, and sampling allows for a lower cost data collection of an entire population.

4.6.2. Case study

A case study is a strategy that involves empirical investigation of a particular contemporary phenomenon within its real-life context using multiple sources of evidence (Robson, 2002). The boundaries between phenomena are not always clear, thus it is important to provide context (Yin, 2003).

This is vastly different from the experimental strategy that was described before, where the research is conducted inside a controlled setting. Case studies also differ from survey strategy where, even though research has context, the ability to explore and understand the context is restricted to the number of variables for which data can be collected (Saunders et al., 2009).

The use of case studies is particularly useful to deeply grasp the context of a research topic (Morris & Wood, 1991). This strategy can lead to answers of questions of why and what, which makes it a common selection for explanatory and exploratory research.

Case studies can be categorised into four groups and are based on discreet dimensions (Yin 2003). These include single case vs multiple case, and holistic case vs embedded case. A single case can be used to showcase a critical, extreme, unique cases or typical cases. Case studies can include multiple cases if there is a need to establish a correlation between the different cases. Holistic vs embedded case studies refer to the unit of analysis (Saunders et al., 2009). If for instance, the research is focused on an entire organisation, it would be considered a holistic case study. If a segment or portion of a larger context is studied and incorporated in the research, it is considered as an embedded case study.

4.6.3. Grounded Theory

The strategy of grounded theory is often used for inductive approaches, although conclusions can be regarded as too simplistic (Saunders et al., 2009). Grounded theory can be considered as theory building that uses both inductive and deductive approaches. According to Goulding (2002), Grounded Theory is ideal for research that aims to predict or explain behaviours or phenomena. It was developed to allow new, contextualised theories to emerge directly from data.

Data collection in grounded theory starts with forming a theoretical framework and collecting data from observations. Predictions are formed based on the data collected and these predictions are confirmed using additional observations. The continuous reference to data is why this strategy can be seen as an inductive and not a deductive approach (Collis and Hussey 2003).

It is important to note that grounded theory should not be used to ignore existing literature. Furthermore, grounded theory does not represent raw data and data collected is conceptual and used to draw conclusions and insights.

4.6.4. Ethnography

Ethnography is the study of social interactions, behaviours, and perceptions that occur within groups, teams, organisations, and communities (Reeves & Hodges, 2008). Ethnography emanates from the field of anthropology (Saunders et al., 2009) and is deeply rooted in inductive approaches. The objective of this strategy is to explain the

social world. Most times ethnographic strategies involve extended participants in observation and is considered as a naturalistic approach to collecting data.

Ethnography is not particularly dominant in business studies (Saunders et al., 2009) but it may be useful to gain insights of a certain context or to interpret theories from the perspectives of parties involved.

4.6.5. Archival Research

The final strategy as outlined by Saunders (2009) is archival research. This strategy makes use of document and data records as a primary source of data. Archival can refer to recent and historical documents although it is not to be confuse with secondary data analysis (Bryman, 1989). Data used in archival research is key to the study because it is a product of the day-today activities (Hakim, 2000).

Research questions in archive studies can change from exploratory to descriptive to explanatory mainly because the focus can shift from the past to present. However, the ability to find conclusions may be inhibited by the nature of the records and archives. A disadvantage to this strategy is that data can be missing or access to data can be denied which makes is difficult to answer all research questions. Therefore, it is necessary to design the research to make the most of available archival data.

This research employs two main research strategies, namely: a case study and a survey (questionnaire)**.** These are most appropriate to establish the impact of Blockchain on ITG for the following reasons:

1. A case study is conducive to this research because it allows the researcher to focus on a single entity and examine variables in context. This case study directs the research on a prime example of a Blockchain organisation, Ethereum. The case study: a) investigates how members of this organisation cooperate, b) explores the structures in place to keep this autonomous system running and c) investigates how the organisation is governed in terms of enterprise IT.
2. Since case studies are targeted and niche specific, it allows for rich quality data to emerge. In the context of Blockchain and its continuous development, it is

more useful to examine an existing organisation such as an Ethereum based platform to study the social proof and implications of the technology on governance principles.

3. A questionnaire allows the researcher to source primary data from subject matter experts. This data will be synthesised and analysed in order explore common themes and patterns that will form the final hypothesis.

4.7. Time Horizon

The timing aspect of research is a key element in the entire process. It is vital to plan research in accordance with a time objective. For instance, if research is designed to capture a snapshot of a particular time, it is necessary to account for that as part of the research design. Saunders (2009) proposes two types of time horizons to consider when formulating a research design. They are cross-sectional and longitudinal.

4.7.1. Cross-Sectional

A cross sectional time horizon is best used for studies that focus on particular phenomena at a particular time (Saunders et al., 2009). This is often due to time constraints held by academic institutions. Cross-section studies mostly see to describe incidence of phenomena at a certain time period or they may explain how independent variables within different organisations are related.

4.7.2. Longitudinal Study

Much like cross-sectional research, longitudinal study can be observational; however, researchers perform observations repeatedly over a longer period of time. Longitudinal studies can span over years because the objective is not constrained by time. The advantages of longitudinal research are they establish a sequence of events and research can easily detect changes in variables or population characteristics.

The most appropriate time horizon for this research is cross-sectional.

The decision between cross-sectional or longitudinal time horizons is informed on the basis of the rapidly evolving technology as the research topic. Due to the fact that Blockchain developments and adoption is rising at an exponential rate, a deliberate attempt to address the problem statement in a fixed time period will reveal relevant

findings. This is imperative in order to avoid any scope creep that may occur on the overall research. Having said this, longitudinal approach could be applied to this study to monitor the sequence of developments on ITG frameworks over time. However, the problem statement is based on current state of governance frameworks, therefore the selected time horizon for this study is cross-sectional.

4.8. Data Collection and Analysis

Data collection is the process of collection of information from relevant sources to answer research questions, test a hypothesis and evaluate an outcome (Dudovskiy, 2011). The techniques of collection data can be divided into two types i.e. primary and secondary methods.

4.8.1. Secondary Data Collection Techniques

Secondary data is data that has already been published in journals, reports, books etc. (Vartanian, 2011). Resources are widely available and can be used to support a hypothesis. Selecting secondary data should be done with a clear set of criteria as this creates reliability and credibility.

4.8.2. Primary Data Collection Techniques

Primary data collection can fall into two groups, quantitative and qualitative (Datt, 2016). Figure 4.3 illustrates the breakdown of common data collection techniques in primary research grouped by quantitative and qualitative data (Saunders et al., 2009).

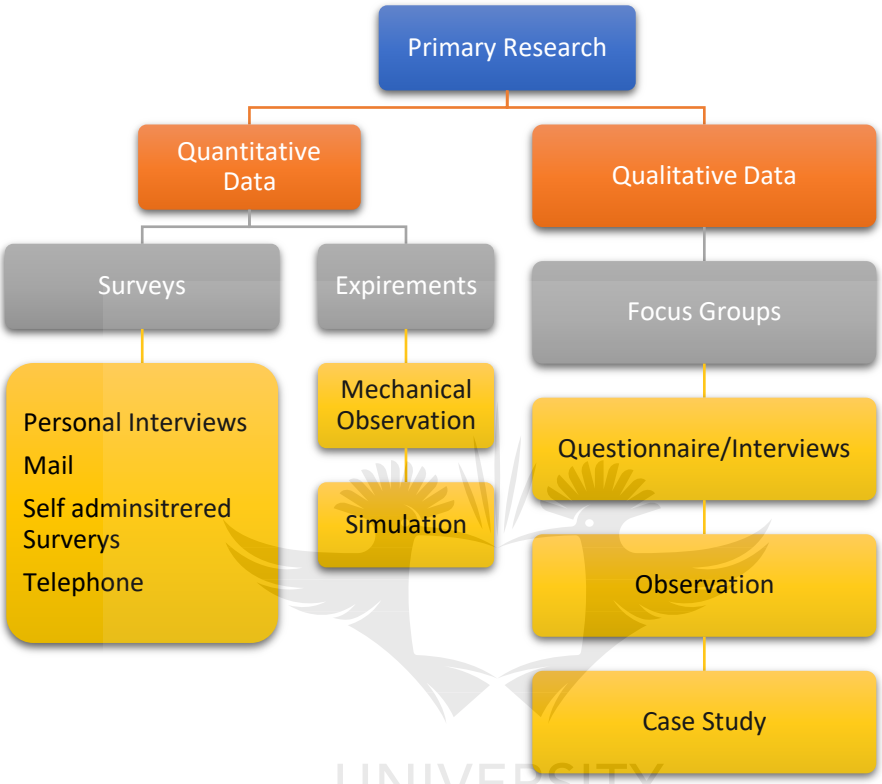


Figure 4.3: Qualitative and Quantitative Techniques

4.8.3. Qualitative data collection

I. Interviews

Interviews are the most common type of data collection techniques for qualitative research. Unlike the quantitative type, qualitative interviews make use of open-ended questions and have a conversational format. The interviewer can ask the same set of questions to participants but can change the order, wording and can choose to use follow up questions to clarify the meaning of the questions or answers given.

II. Questionnaires

Qualitative questionnaires attempt to elicit more in-depth responses. Surveys that are carried out during a certain period of time are known to have a cross-sectional design (Mathers & Hunn, 2009). They provide a snapshot of the thoughts or activity during at that particular time and often take descriptive or exploratory form. Questionnaires that are based on an epistemological approach aim to understand the conditions of truth, belief or justification (Ichikawa & Steup, 2017).

III. Focus Groups

Focus groups employ the use of interviews with a small group of people. This technique allows the researcher to efficiently gather a general consensus of opinions in on session (Singh & Nayak, 2015). The focus group often includes homogenous groups of people, for example: a group of students, group of IT directors, group of athletes etc (Singh & Nayak, 2015).

4.9. Data Analysis Techniques

Data analysis is the process of reducing data to a story and interpretation (LeCompte & Schensul, 1999). Data analysis for qualitative studies differ to that of quantitative studies, however comparisons of data collected to existing data is critically important for both approaches (Dudovskiy, 2011). Quantitative data uses descriptive and inferential numerical analysis, while qualitative analysis employs the use of description, thematic or image analysis (Creswell, 1997).

4.9.1. Qualitative data analysis

Given that this research takes on a qualitative approach, it is inevitable that the answers to research questions will be encapsulated in words and not figures. The amount of words generated in questionnaires will be summarised. This requires the researcher to highlight the relationships between variables and themes. Additionally, the research may have to relate the ideas or behaviour of interview participants to their biographical characteristics. A theory can then be developed using advanced testing and analysis (Lacey & Luff, 2009).

To analyse qualitative data, some or all of following processes are required (Lacey & Luff, 2009):

- Reviewing, reading and listening to familiarise oneself with the data;
- Transcription of audio recorded content;
- Organising and indexing data for easy identification and access;
- Anonymity with regards to sensitive data;
- Indexing (or coding);
- Identification of themes and patterns;
- Re-coding;
- Developing provisional categories;
- Exploring relationships between categories;
- Refining themes and categories;
- Developing a hypothesis and incorporating pre-existing knowledge;
- Testing the theory against data collected;
- Writing reports that include excerpts from the original data (e.g. quotes from interviews).

It is not always necessary to go through the processes mentioned above if the researcher is simply interested in identifying the correlation of variables or trying to address a specific question (Lacey & Luff, 2009). There are three broad ways of analysing the data further:

1. One way could be in simply counting the number of times that a specific theme, word or concept has occurred in a narrative. The qualitative data can then be subject to statistical analysis. This kind of analysis is not truly qualitative.
2. For a thematic analysis, the research needs to go more in depth. All sentence or paragraphs that refer to a common theme can be given a particular code and can then be examined in more detail.
3. For theoretical analysis, such as grounded theory, the researcher may be able to test the theory against existing theories or against further analysis of data. The researcher may also choose to source contradictory theory to fully consider their findings. This process is called “Analytic Induction” and is often used to build and test emerging theories.

According to Saunders (2009), there is no specific way of analysing diverse data, however all qualitative data can be analysed using three processes. The first is to summarise concepts, the second is to categorise concepts and the third is to structure concepts using a narrative. Furthermore, different strategies can be used for deductive and inductive approaches.

Since qualitative research can either be inductive or deductive. One must select analytical techniques that are best suited for the selected style, inductive research. The next section focuses on unique ways to analyse inductive data.

4.9.2. Inductive Approach to Data Analysis

Inductive coding begins with close readings of text (Thomas D. R., 2006). It is important that the research considers ambiguity that can be inherently found in text. The research must identify segments and units and then categorise them using labels. At some stage the researcher might interpret the meaning of a category and write a note about it. The category may also be linked to other categories in various relationships, such as a network, a hierarchy of categories, or a causal sequence (Thomas D. R., 2006)

Table 4.3 describes inductive procedures that can be followed to analyse data (Thomas D. R., 2006).

Table 4.3: Process of Inductive Data Analysis

Process	Description
Preparation of raw data files	This process involves formatting raw data files into the same format. E.g. font, margins, questions, comments etc. It is essential to create a backup of raw data for each interview.
Close reading of text	Once the data has been formatted, if should be read thoroughly so that the researcher is familiar with the themes and details in the text.
Creation of categories	Once the content has been read through, the researcher must identify and define categories or themes. The broader categories are derived from the research objectives. And the lower categories are derived from various interpretations of the raw data, this is called in-vivo coding.
Overlapping coding and non-coded text	Segments of text can be coded into more than one category, and a large some of text can be assigned to a different category. It is important to look out for text that may not be relevant to the evaluation objectives.
Continuing revision and refinement of category system	The research should look for subtopics and contradictory points of view in each category. The researcher should also look for appropriate quotes to convey the theme and combine linked categories if interpretations are similar.

4.10. Conclusion

The aim of this chapter was to explore research methodologies, philosophies, approaches, strategies, choices, time horizons as well as data collection techniques. These elements form part of what is known as the research onion (Saunders et al., 2009).

The proposed research design will focus on gathering existing information in the form of literature studies on Blockchain and IT governance as well as performing single case study on Ethereum, a popular decentralised autonomous organisation. This data will be marked as secondary data.

The primary data for this research will consist of data collected and analysed from an online questionnaire completed by subject matter experts.

To conclude the outcome of the research design, it must be noted that each choice has been deliberately chosen in relation to the research topic. The problem statements and research objective as described in chapter one has been carefully considered as a guide for the selection of philosophies, approaches and strategies.

The selected research philosophy for this study is epistemology and thus interpretivism will be used to analyse themes and patterns that emerge from as the study progresses. The research approach will be inductive to allow for a formulation of a new hypothesis. The selected strategies will be an in-depth case study on an Ethereum organisation. As such the researcher will employ the use of open-ended questionnaire to probe information from the participants. The dominant research choice is mono-method qualitative, which will allow for deeper insight and understanding of the complex nature of the subject. A cross sectional time horizon will be applied to the research in an effort to encapsulate the findings in the context of the current Blockchain developments.

The research can therefore be described as:

An empirical qualitative, inductive and cross-sectional study of Blockchain and IT governance, which attains data through literature reviews, a questionnaire and a case study on Decentralised Autonomous Organisations. It inductively analyses primary data from a questionnaire and a holistic case study using thematic coding methods from which recommendations are made.

The research design and methodology are diverse and complementary based on the research objective.

The value of this chapter lies in the meticulous and careful consideration and selection of the research design. In addition to that, the chapter specifies why alternative methods may not have served this research best and substantiates motives for the selected design.

5. Chapter 5 – A Case Study of Decentralised Autonomous Organisations

5.1. Introduction

A DAO is a computer program that runs a distributed peer to peer network (Overy, 2016). DAOs are created to operate like virtual companies without a central governing body. They are controlled by communities of people. The individuals in these communities may come and go. DAOs achieve this type of collaborative governance by programming organisational processes into code. The code runs on a digital platform that is accessible to all parties in the organisation, with the exception of organisations with specific confidentiality mandates.

5.2. Background

DAOStack is one of the many online DAOs available and it is also an operating system for collective intelligence.

In centralised organisations, the power and decision-making authority is held by executive members or top-level management. This creates a hierarchy / decision-making structure where the top-level employees' control and direct the organisation.

On the opposite end of the spectrum are decentralised organisations where the process of decision making is delegated. Executives assign parts of their responsibilities to management and communicate often to oversee operational processes. However, different teams still need to ensure their processes align with the main business vision and broader plan (GoCo, 2017). They do, however, make up their own rules. No company is 100% centralised or decentralised, instead there are varying degrees of both (Drube, 2018). Johnson & Johnson is a well-known example of a business with a decentralised structure. It has over 200 units that function autonomously.

A DAO is similar to a decentralised organisation; however, the key difference is that DAOs exist as virtual computer networks. DAOs rely on distributed ledger technology to record and enforce decisions and organisational processes. This could include

aspects like issuing shares, appointing a CEO, voting on proposals, and paying salaries (e Inc., 2017)

The following is a thought experiment on a use case of an autonomous agent (Hearn, 2017).

Imagine a self-driving electric car is programmed to cruise around in search for passengers. After successfully picking up and dropping off passengers, the car decides to head to a charging station to use its profits to recharge its battery. Aside from the initial programming, there is no human intervention or control in helping determine the car's mission.

This idea describes how DAOs could help power leaderless organisations in the future. The concept is that if Bitcoin can do away with financial middle men, one day organisations can operate without hierarchical governance.

5.2.1. Responsibilities of IT Directors

Every organisation is unique and may require different responsibilities from their IT directors. This often depends on the size of the organisation and the scope within the enterprise. The industry also has an impact on the role of the director. For example, government, non-profit, healthcare sectors require IT directors but in different contexts. Nevertheless, regardless of the industry, there are broad and common responsibilities that all IT directors share (ISACA, 2012).These are listed below:

- Developing and overseeing Specific, Measurable, Accurate, and Reliable and Timely (SMART) metrics for hardware, software, and storage.
- Guaranteeing a strategic capacity plan.
- Liaising with senior level IT managers, making hiring decisions, handling employee performance.
- Communicating and collaborating with the technology team.
- Determining business requirements for IT systems.

- Coordinating IT activities to ensure the security, privacy and availability of data and network services.
- Managing IT risk to an acceptable level.
- Overseeing budgets and financial forecasts.
- Implementing IT related policies from board members and reporting back.
- Identifying and recommending modern technology solutions.

Before the building blocks of a typical DAO are explained, it is necessary to establish how DAOStack transcribes governance practices into executable software protocols. This is covered in the next section.

5.2.2. Agencies in DAOs

The foundations of DAOs are smart companies or agencies. A smart agency is an atomic governance unit that is managed and operated with smart contracts (DAOStack, 2018). Agencies should have their own tokens, reputation systems and a governance system. The token is associated with the company's resources, the reputation is based on the credibility in company matters and the governance system consists of the bylaws that are written and executed in smart contracts.

The agency can come up with any suitable by-laws to create the governance protocol (DAOStack, 2018). An example of one is a proposal-based governance system. This allows members of the network to vote whether they agree or disagree to company proposals (Jentzsch, 2017). A majority vote is required for approval and execution (DAOStack, 2018). The execution is an automated action once approved. Proposals could be about shareholding, token distribution, or any other endeavour in the company (eInc., 2017). The votes can be weighted by voter reputation or any other attribute deemed necessary. Figure 5.1 is a heuristic visualization of what this could look like (DAOStack, 2018):

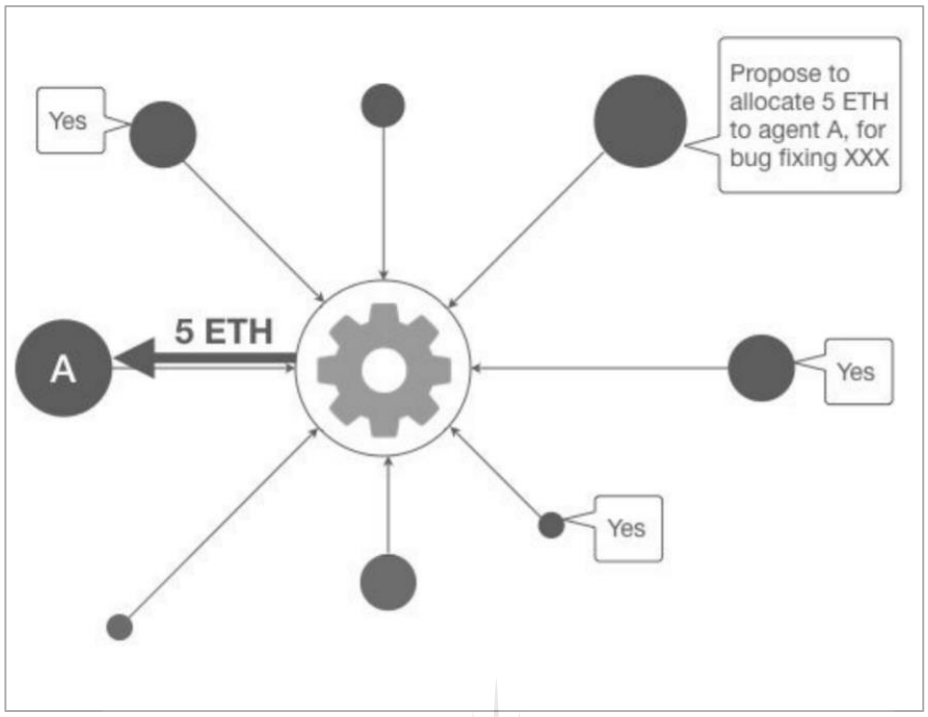


Figure 5.1: A Schematic Blockchain Company

In this figure, the solid balls represent agents within the company and the proximity to the centre indicates their influence or reputation (the closer they are to the centre, the stronger their influence or reputation). The size of the solid balls reflects the quantity of tokens the agents possess. In this example, an agent is proposing to allocate five allocate five Ethereum tokens (ETH) to Agent A for her contribution to fixing the bug XXX. The agents of the company vote and the majority, weighted by reputation, approve of this transfer. The contract automatically executes the suggested token allocation.

This example could be adjusted in relation to conventional ITG practices, the same could be done for:

- Determining and approving business requirements for IT systems.
- Approving the purchase of new software or hardware for the company.
- Overseeing departmental finances, including budgeting and forecasting.
- Implementing procedures derived from policies
- Reporting

It is evident from the example above that administrative tasks and decision making can be automated in a DAO.

The tasks and decisions are guided by rules that cannot be broken; they can only be edited in accordance with the fundamental policies themselves. They may or may not be autonomous depending on the agency's chosen governance system. For example, the agency can reserve a veto option on its own decision-making process for another agency (DAOStack, 2018).

5.3. DAO Topologies

There are various modes of decentralisation, and accordingly various modes to think about DAOs with respect to an agency (DAOStack, 2018). The most common way to conceptualise DAOs is in the assembly mode.

5.3.1. Assembly Mode

In the assembly mode, numerous agents take part in decision making within a single agency. This is done via smart contracts, assuming reputation or stake represents decision-making power. This model is distributed fairly but is difficult to scale due to the technical capacity required to process data while maintaining resilience. Scalability and resilience are addressed in the next section.

5.3.2. Fractal Federal Governance mode

The fractal federal mode is extreme in the sense that the DAO exists as an agency within a few agents, where each agent is an agency with agents.

5.3.3. Complex mesh-network

The complex mesh network arises from agencies within the infrastructure provided by the DAO stack. The governance part of DAOstack lies within the agency. Agency is a unit of governance in a state-transition function (DAOStack, 2018) that collects inputs from agents with Blockchain addresses and executes an output in terms of the state transition (Figure 5.2).

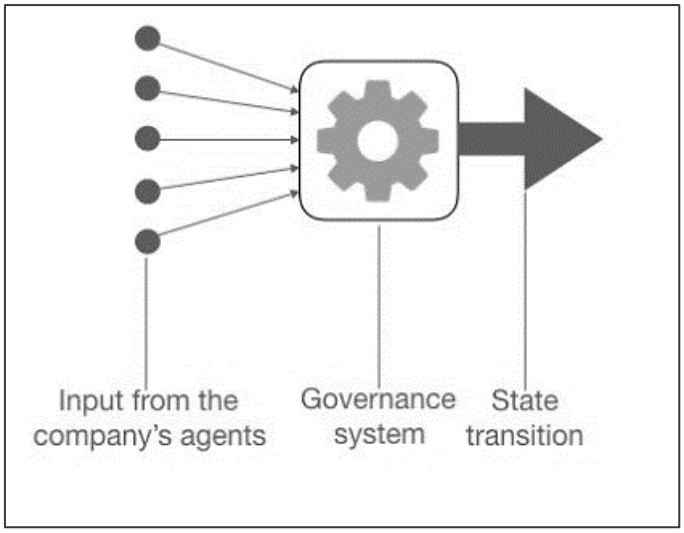


Figure 5.2: Governance State Transition (DAOStack, 2018).

The following is an example of this state transition function in a complex mesh network:

A simple agency called "Fundis" manages an Ethereum (ETH) fund. This agency has its own native token called FND, an acronym for Fundis. The agency has three basic governance rules:

1. The first rule is that the only company-wide decision that the agency takes is to make investments. This is done by sending ETH from the main wallet to a certain Blockchain address. An agent within the company can initiate the action by proposing to send a specified amount of ETH to address A. Then all agents vote yes or no to the proposal, each vote is weighted by the number of FND that the vote has in their address.
2. The second rule is that upon establishment, FND tokens are issued to buyers for a period of one week. The rate is one FND per ETH.
3. The third rule is that any FND owner can send their token to the main Fundis wallet and in return get a share of the ETH. This is based on the existing ETH in the Fundis wallet at the moment. When the owner of the FND does this, the FND sent is destroyed in their wallet.

As simple as this three-rule governance system is, there are some immediate issues:

a. It may be difficult get a majority vote on a proposal using weighting by stake. This issue is related to governance scalability. This is discussed in the next section.

b. A 51% attack can hack this governance system. This can occur when a single agent has enough liquid capital to obtain more than half of the FND in the network. This results in one individual dominating the votes and influencing the governance of the DAO. This problem is related to resilience, which is covered in the next section.

c. It is uncertain that the agents who hold the most tokens would make the best investment decisions. This brings up the question of meritocracy which is addressed in the next section.

d. Another risk is if an agent proposes that all Fundis ETH be distributed into the addresses of agents that vote yes on a particular proposal. This scenario demonstrates that resilience is a complex issue to solve.

e. Lastly, the creators of Fundi might eventually realise that the governance system is flawed. However, once the agency has been deployed that problem will be out of their control because the system is not upgradable.

In the Fundis example, there are four types of inputs that agents can make in the organisations:

- They can submit a proposal,
- They can vote yes or no,
- They can buy FND with ETH from the agency
- They can send FND to the agency to claim back the ETH.

Fundis as a DAO has three possible automated actions that it can make based on the rules of its governance system. They are:

- Issue and send FND to send agents in the first week.

- Send ETH from its main wallet to agents who want to reclaim, while destroying the agents' FND.
- Send ETH to an address after a success proposal from the network.

5.4. Solving the Fundis Problem

5.4.1. Reputation Systems - Meritocracy

Instead of basing votes on the number of tokens that agents hold, the company can create various balance sheets that denote the influence of agents.

An agent cannot transfer reputation scores to another agent. It would not be practical to lend one's reputation to someone else. However, it is possible that a company can create different types of reputation categories that can be assigned to separate roles or in different situations. Hence forming a meritocratic governance system that is based on the unique contributions of agents.

One method of allocating reputation would be via proposals that are directly linked to the contributions or work performed, which can be recorded in the Blockchain. Reputation can also be programmed to include payments for agents that have been awarded reputation tokens. In DAOStack, this concept is called reputation flow (DAOStack, 2018).

5.4.2. Scalability & Resilience

Scalability and resilience are key factors in DAOs but can work against each other. This is because decentralisation requires an open protocol that is available to different participants under different rules. To have a resilient system, it is necessary that enough participants review decisions. However, it can be difficult to get the attention of all participants every time a decision needs to be made. Additionally, computing power may be limited and that could slow down the voting process when a DAO grows in number of participants.

DAOStack proposes three ways to resolve the friction between scalability and resilience. These include compositionality, attention monetisation, and relative majority. These concepts are equivalent to Blockchain mechanisms known as Sharding, Gas and Off-chain computations. These concepts are discussed below.

5.4.3. Compositionality

Compositionality can be described in the following two examples (Figure 5.3). Company A has nine agents with equal votes. Company B has three agents with equal votes. Each of those agents represent a sub-company composed of three human agents with equal votes.

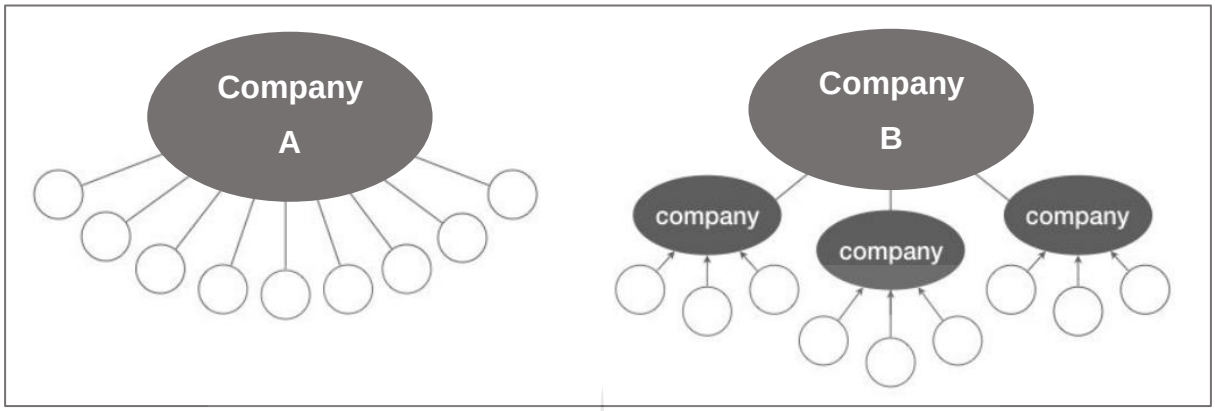


Figure 5.3: The Assembly Vs Federated Governance

The sub-companies of Company B cast their votes as soon as they develop a decision based on the internal majority.

In Company A, it requires the attention and consensus of a minimum of five human agents to make a decision. Whereas Company B needs only four human agents to make a decision.

This example illustrates how fractalisation makes DAOs more scalable. Compositionality is key to scaling any system (Meredith, 2015). One can argue that compositionality means that a lower number of human agents can override the system, thereby compromising resilience. Nonetheless, in Company B, not just any arrangement of four human agents can form a decision in the mother company. Under different arrangements the resilience in Company B can be stronger or weaker.

5.4.4. Monetization of Attention

It requires attention and time to form a decision, and the more decisions that need to be made the more divided that attention becomes. To create a resilient system, attention can be monetised to reflect its scarcity. In the Ethereum network the pricing value required to execute a transaction is referred to as gas (Ethereum 2016), and in the Bitcoin Blockchain, these come down to transaction fees. For the governance of

DAOs, attention needs to be tokenised and that token should reflect the group of agents from which attention is required. In DAOStack, the internal decision can use DAO tokens, whereas inter-DAO activities use GENs - ecosystem tokens created by DAOStack. It is important to note that tokens do not buy decisions nor votes, they buy the attention over proposals.

I. Relative Majority

A straight-forward way of scaling decision making is by restricting the approval of decisions to a relative majority (DAOStack, 2018). This refers to the majority of those who cast votes and not necessarily all the voters in the system.

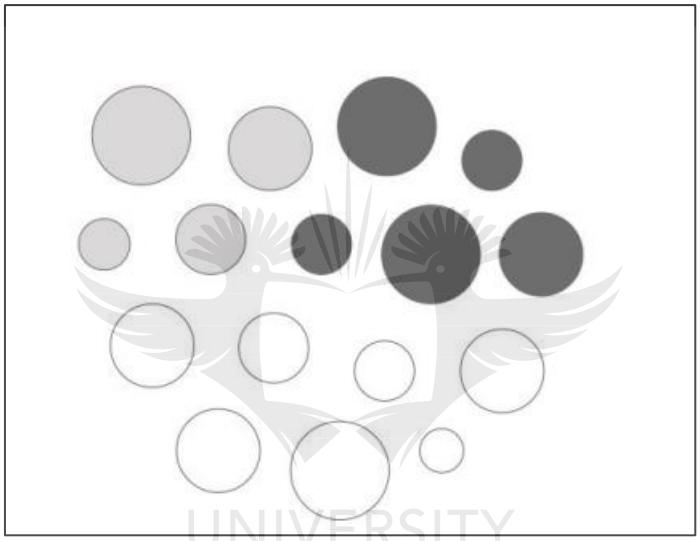


Figure 5.4: Relative Majority Example

In Figure 5.4, the voting power of the agents is represented by the size of the balls. The empty balls are individuals who have not cast any votes. The light balls symbolise individuals who have voted no, and the darker balls are for yes. It is evident that there is not absolute majority, but there is a relative majority.

The relative majority requires a finite time window for the proposal to be considered. To solve this problem, other governance systems introduced a minimal amount of voting power that needs to be engaged into a decision to qualify that decision for approval. This is known as quorum. The disadvantage of quorum is that it is impossible to fix the right amount of it (DAOStack, 2018). The next section discusses a resilient governance protocol that filters the process of submitting proposals.

5.4.5. Attention Funnel

Another way to improve scalability is to focus all of the attention at any given time on a few decisions thereby enhancing the attention per decision. This can be done by creating a number of steps that participants must follow. The following steps are an example of this:

1. **Proposals:** They are initiated by agents and all agents vote with a yes or no.
2. **Reputation:** Votes are weighted with reputation tokens.
3. **Boosted Proposals:** Boosted proposals are given finite time frames for voting. After the set time period, a relative majority of voter's reputation is used to make a decision.
4. **Quiet Ending:** The final decision cannot be changed for a fixed period of time after it becomes effective. This is to avoid finalisation attacks. E.g. If on the last day of voting, the majority changes from a yes to a no, the voting interval is extended for another day.
5. **Boosting Stack:** There can only be a specified number of proposals at any given time. Any other proposals are queued and ranked by priority. When a proposal has been finalised, a queued proposal with the highest ranking enters the stack.
6. **Promotion:** Anyone can promote a proposal to a higher ranking in the queue by placing GEN tokens in stake. If the proposal is successful, the promoter retrieves back his or her tokens plus some profit. Or else, the tokens are destroyed or sent to the DAO.
7. **Ranking System:** The ranking system can be a programmable function that automatically ranks proposals based on priority or other variables.

5.5. Blockchain Governance Structure

There are two types of actions that can be programmed into the governance of a DAO (DAOStack, 2018), permissible and forbidden actions.

Permissible actions are operational rules that trigger the agency functionalities. For example, if the majority of reputation holders approve a proposal to issue a token, a token will automatically be issued. This will be based on smart contract triggers set out in the governance schemes.

Forbidden actions are the restrictions that must be respected and cannot be violated, even by an approved scheme. For example, if the DAO approves one million tokens, token-issuance schemes will only function as long as the sum of the tokens issues is less than one million. These are called global constraints. Constraints can be upgradable if a predefined condition has been met.

In DAOStack, global constraints and governance schemes are denoted in elements. Such elements provide protocols for governance and protocols to change the main protocols.

5.6. Layers of DAOStack

The DAOStack provides foundational tools for the creation, operation and governance of DAOs. In short, it can be compared to what WordPress does for the web.

At the bottom of the DAOStack is Ethereum (Figure 5.5). This is the operating system for DAOStack. The next layer consists of public registries that are curated by the DAOStack community and serves the global ecosystem.

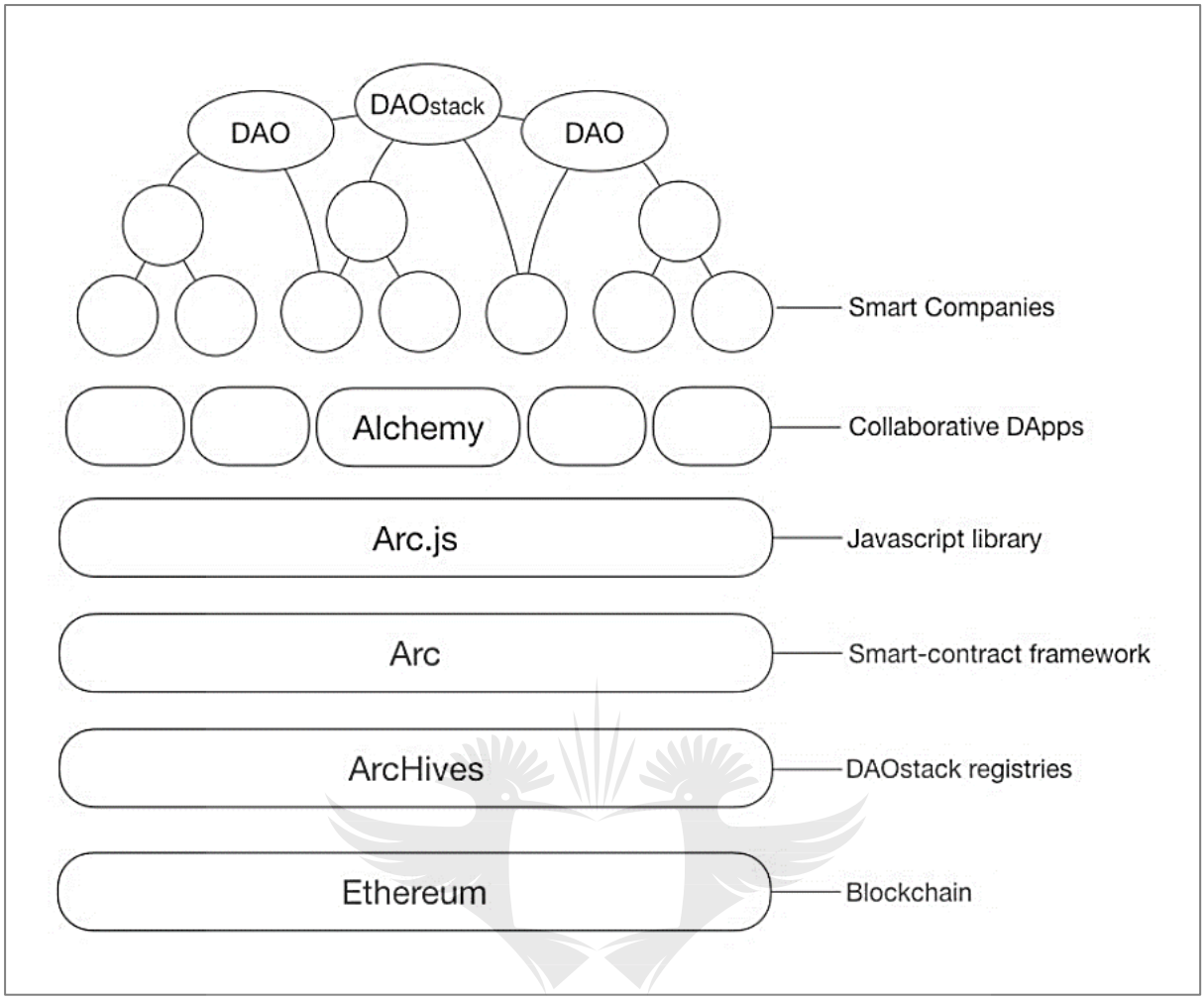


Figure 5.5: Layers of DAOStack

All DAOs on DAOStack comprise of a series of smart contracts that are deployed through a governance framework called Arc. Arc forms part of a programming language called Solidity that was invented by the Ethereum.

Above the Arc layer is the Alchemy layer. Alchemy is a Decentralised Application (DApp) that was built by DAOstack, it allows anyone to create a new DAO. This DApp relies on a JavaScript library that operates the Arc Solidity framework. Alchemy is designed to facilitate developers in creation applications without the need to work directly on the solidity code.

Arc

Arc is a basic operating system for DAOs. It is open source, modular and comes with a public library of template governance modules that are called elements. Elements

evolve based on the needs of the users because they allow users to easily modify or upgrade a governance system to fit an organisation's needs.

Agencies can create their own governance system by combining different elements, this specifies rules, policies, assignment of resources include tokens as well as non-transferable assets like reputation.

5.7. The Dao Hack

In June 2016, a decentralised venture capital fund called The DAO was attacked by unknown hackers whom exploited vulnerabilities in the smart contracts. This attack highlighted that despite DAOs being self-governed engines, they still require effective IT governance and are subject to misuse. The vulnerability that lead to the hack was traced to an external call present in a code path that should have been allowed to be executed only once per stakeholder (BlockCast 2016). This code path was placed before a section of the code that revokes the rights of stakeholders to trigger the code path after its first execution. This vulnerability allowed the hacker to repeatedly execute the code path, thereby draining excessive funds from the contract than should have been possible (Leising, 2017).

The hacker managed to drain 3.6 million ETH, which was worth approximately $50 million at the time (Falkon, 2017). Fortunately, the funds were locked for 28 days due to the nature of the system, which prevents creators of Child-DAOs from withdrawing assets for a total of 27 days after creating the address (Sharma, 2017). This time frame gave the community a chance to diverge the protocol of the Ethereum chain to refund investors.

Technically speaking, the hacker ran a valid smart contract on the system. However, it was ill-intentioned and manipulative.

This is an aspect of DAOs that are difficult to manage because they stem from humans, and some may argue that humans are more difficult to govern than systems.

Considering that up to 5% of all smart contracts are potentially in danger the demand for a decentralised auditing platforms and good governance grows (Block Cast, 2016).

The next section discusses how tacit and explicit knowledge could be used for effective governance, and how applying it could have possibly prevented this hack.

5.8. Tacit vs explicit knowledge in business

The cohesion of explicit and tacit knowledge is key in creating and understanding the dynamics of knowledge in an organisation (Computer Business Research, 2018).

Explicit knowledge is used in a company to help sustain organisational procedures, as well as generate and articulate information and data accordingly (Evans & Smith, 2001).

Compared to Tacit knowledge, explicit knowledge is easier to transfer and map out in computer systems because it is direct and requires a lower level of context to be understood. Explicit knowledge is found in databases, memos, notes, documents, etc (Brézillon & Pomerol, 2002).

On the other hand, tacit knowledge, which is knowledge that is stored in every person through his or her experiences, intuitions and observations is more difficult to transfer (Evans & Smith, 2001).

In the case of The DAO hack, it would have required some experience and a strong technical background to identify the flaw in the code. Mostly because, at face value, there was nothing inherently wrong with the algorithm. It required strategic thinking to identify ways to either manipulate or prevent manipulation on the system.

Solidity, the programming language used to build the DAO, was invented in 2014. The hack occurred in 2016, giving the community of developers two years to familiarise themselves with all aspects of the protocols.

A combination of explicit and tacit knowledge of smart contracts, information security and hacking could have been instrumental in preventing the DAO hack. However, considering that DAOs are relatively new in the IT industry, there are a severe skill shortage in the space (Castillo, 2017).

This case highlights that knowledge accumulated with years of experience is not only lacking in DAOs, but difficult to transfer in a digital environment where participants are located in difference parts of the world. This type of knowledge does not replace

explicit knowledge, but it plays a key role in monitoring, controlling and evaluating activities in DAOs.

5.9. Implications of DAOs on ITG

As outlined in Chapter 2, a literature review on ITG, COBIT (2015) describes governance as ensuring that stakeholder needs, conditions and options are evaluated to determine balanced, agreed-on enterprise objectives to be achieved; setting direction through prioritisation and decision making. In summary, COBIT suggests that the following aspects should be achieved for effective ITG:

- Accountability of IT.
- IT compliance to rules and regulations.
- Satisfying the needs of the board and stakeholders.
- Managing IT Risk.
- Providing value to the business and control of work done, monitoring performance and compliance against agreed-on direction and objectives.

5.10. Decision making in Hierarchical Organisations

In general, CIOs make many important decisions a week, and they make them quickly with data that is gathered informally (CXO Systems , 2003). CXO research has found that CIOs make one to five significant decisions a week, which are made in ten to thirty minutes. Many CIOs rely on emails, staff and peer conversations to provide information that guides their decisions. According to CXO's research on fifty CIOs most IT executives appear to gather anecdotal information and rely upon experience, intuition and tacit knowledge to synthesise information in order to make informed decisions.

The study by CXO systems concludes the following:

1. IT executives need real, unaltered and accurate information in order to make the best decisions. They require strategic information critically and focus most on business performs optimally. This can be difficult to do when people minimise negative information to portray that things are under control. This is

an aspect of human endeavours that is required but can be detrimental to decision making.

2. CIOs mostly use acquired information from various sources which mostly include reports and emails and rely less on direct access to data. They rely on senior managers to report back on the summary of data or status of integrated systems.

3. CIOs frequently measure the least important pieces of information and measure essential information less frequently. This is due to time sensitivity of different types of information, and the effort and costs involved in gathering frequent updates.

4. IT executives can easily run the risk of being out of touch of the realities at operational level, this is because they do not deal directly with data at its source.

5.11. Comparison of ITG Factors in DAOs and Hierarchical Organisations

To establish whether DAOs extend or reduce the conventional roles of IT directors, this section includes a comparative study on the factors of ITG that are considered for decision making in hierarchical organisations (ISACA, 2012) and DAOs (DAOStack, 2018).

Governance factors taken from COBIT's ITG definition was used as the main frame of reference. This helps to establish whether one case extends, corroborates, contradicts or corrects the other.

The ground for comparison is that both organisational models are designed to direct and control enterprises. Hierarchical organisations are traditional and widely adopted, whereas DAOs are a novel modern concept. It is important to consider that DAOs are still being developed and experimented on and have not reached mainstream adoption (DAOStack 2018, Dash 2016, eInc 2017). Various organisations are exploring the possibilities of DAOs (Jentzsch, 2017, Buterin 2017). It is likely that further research will follow that will expand on the effective application of DAO frameworks.

Table 5.1 contains observations from the whitepaper of DAOStack and the guidelines of COBIT 5. These are simply high-level representations of the details elaborated in the respective white paper and guidelines. These factors were selected to reveal the differences and similarities between DAOs and Hierarchical organisations.

Table 5.1: Comparative analysis of Decision-Making Factors

Governance Factors	Hierarchical Organisations	DAOStack
Managing Stakeholders	Different strategies are used to manage internal and external stakeholders.	Stakeholders exist within the DAO as agents with weightings t measure influence. Stakeholders can be invited to vote on decisions in the DAO.
Stakeholder Needs	Stakeholder needs are often used to form organisational objectives; however, needs can conflict and require human judgement.	Needs of stakeholders can be recorded as proposals with priority rankings. These proposals are executed as permissible actions in the DAO.
Organisational objectives	Objectives are based on a flexible framework that includes principles such as: • Alignment of IT and business strategy, • Managed IT-related business risk, • Delivery of IT services in line with business requirements. Using tacit and organisational knowledge, it is easier to identify high level objectives.	High level objectives must be codified into measurable tasks and procedures, programmed into the governance protocol. Goals must be explicitly documented and coded.
Business intelligence (BI) Tools	Making decisions requires a balance of quantitative and qualitative approaches. BI tools can be used to form decisions. However,	BI tools can be built as an application layer on top of the blockchain. However, decision-making power is distributed among agents who vote on proposals.

	the decision maker also relies on tacit knowledge, interpretation of hard data, intuition, and technical skills. The responsibility and accountability of decisions are held by single individuals. E.g. CIO or CTO.	Tokens like reputation or stake can be used to quantify decision-making power. Voting can be incentivised. Decision are automatically executed when there is a majority vote.
Providing Value to the business	Directors provide value by controlling, monitoring and evaluating the organisation. This requires them to make informed decisions and take accountability for those decisions.	Value lies in the automated decision making, transparency, accuracy, resilience and meritocracy. Accountability of decisions is distributed across the network.
Compliance to IT rules and regulation	Internal and external auditors can be appointed to examine and analyse compliance. This process does not severely interfere with regular activity.	IT rules and regulation are programmed as schemes in the smart-contract framework of DAOStack. Protocols must be upgraded when internal or external laws have changed. This may affect the availability of certain functions on the DAO.
Managing Risk	Directors are expected to recognise pain points and triggers related to IT risk such as data loss or project failure. All documented	Pain point and triggers can be programmed into the governance protocol. Any vulnerabilities in the code can be extremely damaging to the DAO.

	risks must be controlled at an acceptable level.	
IT Security	Requires collaboration from all levels, it involves both IT and non-IT departments. IT Security policies are set by board members, interpreted as managerial procedures and formed into operational processes.	Security risks should be assessed at inception in DAOs. It is difficult to refactor code after the DAO has been deployed. The advantage is that individuals cannot compromise the system. The disadvantage is that protocols may be “technically” correct but can be bypassed by manipulation. The risk is higher as it could affect the entire organisation.

5.12. Conclusion

One can infer, based on DAOStack's architecture, that DAOs effectively reduce the decision-making power of directors by codifying common governance processes. This is beneficial in reducing the risk of human error in DAOs.

However, human centric skills such as tacit knowledge, intuition and experience are not easily transferable in DAOs. In the long run, and depending on the industry, the collaboration of virtual teams may be challenging as DAOs currently do not provide effective mechanisms for personal engagement. This may force IT directors to develop stronger influence-oriented skills to address some of COBIT's IT related goals like risk awareness, teamwork, innovation, motivated personnel and learning.

With that being said, DAOs can still be considered as an efficient way of conducting corporate voting, facilitating decision making such as appointing a CEO, paying salaries, proposing service level agreements. DAOStack demonstrates that smart agencies can function based on community rules, global constraints and business logic.

5.13. Recommendations

The example of DAOStack and other platforms (Ethereum 2016, eInc, 2017; Slock.It , 2017) indicate that the future responsibilities of directors will focus less on control-based tasks. Many of the examples given highlight democratic, peer-to-peer decision making.

It is recommended that IT professionals, entrepreneurs and educational institutions prepare for the global digital economy by encouraging influence-oriented skills as opposed to control-based skills in governance. This is because Blockchain technology reduces the decision-making authority of directors, by relying on programmable governance protocols. The growing concept of decentralisation demands that IT directors in Blockchain act as orchestrators or facilitators and not as mechanics or controllers.

Directors in DAOs must take on modern governance approaches to add value to the ecosystem. This can be done by expanding their scope of duties, relinquishing traditional powers and authority as well as facilitating collaboration.

6. Chapter 6 – Data Collection and Analysis

6.1. Introduction

This chapter assesses the data collected from an online questionnaire that was completed by 10 Blockchain experts. The data collection process seeks to establish an understanding of the role of IT directors in Blockchain, particularly in DAOs.

6.1.1. Background

The experts that were approached for this exercise include directors in prominent global IT corporations; the head of operations in a leading Blockchain organisation; published Blockchain authors; a Professor with a PhD in Information Systems who specialises in smart contracts; Blockchain business owners; and CTOs in Blockchain start-ups. Each of the individuals participated voluntarily and anonymously.

6.2. Overview of Data collection

6.2.1. Identifying Participants

To send the questionnaire to the most appropriate participants, the researcher conducted an industry analysis over the course of six months and created a list of attributes to look out for in participants before approaching them. This exercise provided the researcher with the knowledge to properly identify individuals with the most relevant experience and knowledge.

All participants were contacted individually based on their background in Blockchain, their current or previous work in Blockchain as well as their experience in the corporate world.

The characteristics of participants include any one or more of the following:

- He/she has published and/or presented research on DAOs.
- He/she has worked or currently works in a position related to Blockchain technology.
- He/she has more than 10 years' work experience and understands enterprise governance and concepts of ITG.
- He/she has a background in IT, software development or solution architecture.

6.2.2. Ethical considerations

While the results of the questionnaire are published, the information pertaining to the identities of the participants have not been disclosed to maintain objectivity and integrity in the analysis. The questions were carefully written to avoid bias or misleading information.

Participants were informed about their rights to ignore certain questions in the questionnaire and to withdraw at any point during the study. The questionnaire was disseminated widely to 50 Blockchain experts in different countries around the world.

6.2.3. Data Collection Steps

The steps for collecting data for this research were as follows:

I. **Step 1: Identifying Objectives: Processes that contribute towards ITG**

For the purpose of this study, COBIT's framework was used as a basis to formulate questions. This step was fundamental in creating a relationship between governance in hierarchical organisations and in DAOs. In COBIT 5, there are five main ITG processes that directors are expected to follow (Table 6.1).

Table 6.1: ITG Processes

Process Code	Name
EDM01	Ensure Governance Framework Setting and Maintenance
EDM02	Ensure Benefits Delivery
EDM03	Ensure Risk Optimisation
EDM04	Ensure Resource Optimisation
EDM05	Ensure Stakeholder Transparency

Each of the abovementioned processes have practices, inputs, outputs and associated goals. However, due to the complex nature of corporate governance (Kemp et al., 2017), this research considered the governance processes only to express the wider, macro system of governance. This approach goes in line with COBIT principle 4 – Enabling a holistic approach as outlined in Chapter 2.

II. **Step 2: Aligning the COBIT Processes with the Research Questions**

Table 6.2 highlights why it was relevant to derive questions from each COBIT5 process:

Table 6.2: Relevance of Questions based on Governance Processes

ITG Process	Relevance in DAOs	IT Goals
Ensure Governance Framework Setting and Maintenance	In DAOs, Governance Frameworks are transcribed into programmable code. Therefore, it is important that participants in a network form a robust governance protocol. According to COBIT 5, this process involves analysing and articulating the requirements of enterprise IT. It also involves putting in place effective structures, principles and practices, with clarity of responsibilities and authority to achieve the enterprise's mission, goals and objectives.	• Alignment of IT and Business Strategy. • Commitment of Executives for making It related decision. • Delivery of IT Services in line with Business Requirements.
Ensure Benefits Delivery	DAOs are created to deliver benefits to the entire entity and participants democratically and transparently. This process is necessary to prevent groups of individuals from leaving the DAO through a hard fork or finding ways to corrupt the system. Therefore, IT assets and returns on investment should be accurately delivered throughout the system.	• Enterprise achieves optimal value of IT. • Optimal IT value creation with management. • Individual IT Investment Value Contribution.
Ensure Risk Optimisation	DAOs are vulnerable to IT risks because important information is constantly exchanged within them. The organisation's risk appetite should be agreed upon, understood and clearly articulated to all participants. This can help prevent risks such as hacks, hard	• Identify IT Risks, Communicate It Thresholds • Effective Management of Critical IT Risks • It Risks are kept within Appetite

	forks and manipulation of people or processes.	
Ensure Resource Optimisation	It is important that well governed organisations ensure adequate and sufficient IT related capabilities. This includes its people, processes and technology. Much like Hierarchical organisations, DAOs require all three to operate effectively.	• Resource needs to be met with optimal capabilities. • Resource allocation within budget constraints. • Optimal use of resources throughout life cycle.
Ensure Stakeholder Transparency	This process ensures that stakeholder communication is clear and transparent and that requirements are met. In DAOs, this process is crucial to in acquiring external buy-in and investments, particularly when launching ICOs. This process includes assurance review reports and the assessment of reporting effectiveness.	• Commitment of Executive to make IT Decisions • Transparency of IT costs, Benefits and Risk • Delivery of IT Service in Line with Business Requirements

III. **Step 3: Questionnaire Design**

The questionnaire was exploratory, and the questions were open-ended. The questionnaire was designed to allow participants to openly share their thoughts on governance in DAOs and provide insight for their reasoning, thereby achieving an epistemological approach, as discussed in Chapter 4. Additionally, there was a specific focus on facilitating the interpretation process by phrasing the questions clearly, descriptively and including examples. This improves credibility of the interpretation and falls in line with the research design choice of interpretivism.

The questionnaire was also designed with the research objectives in mind. Each question aims to probe at topics associated with the main research questions.

However, the researcher was aware that due to time constraints the questionnaire can only address high-level aspects of governance.

IV. Step 4: Questionnaire Administration

Participants were asked to complete the questionnaire online using a survey platform called TypeForm. The selected participants are all involved in the Blockchain industry and understand DAOs and corporate governance. This goes in line with the cardinal principle of context as mentioned in Chapter 4.

V. Step 5: Interpretation of Results (Data Analysis)

The interpretation of results was done using thematic coding and was administered using a qualitative analysis software tool called Qualitative Data Analysis (QDA) Miner. The coding methods rely on a set of predefined themes based on the notions and in the responses. The researcher placed an emphasis on triangulation, as mentioned in Chapter 4. Triangulation was performed to avoid systematic bias. The use of multiple diverse data sources and the information from the case study in Chapter 5 was used as background while reviewing the results to develop a comprehensive understanding of the phenomena.

Figure 6.1 illustrates the themes that were derived from the results.

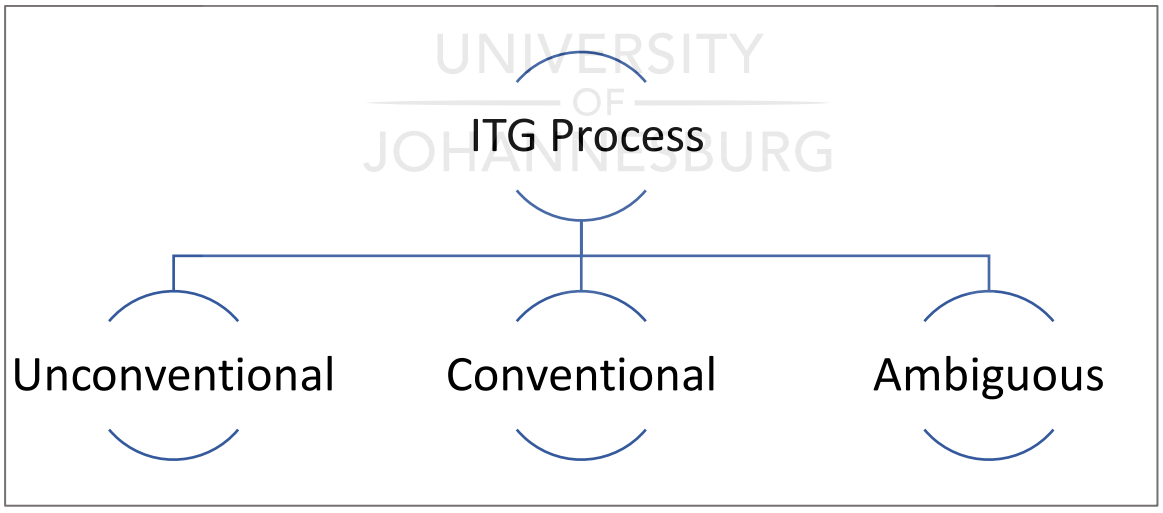


Figure 6.1: Coded Theme Structure

Table 6.3 describes each of the codes and the theme they represent.

Table 6.3: Thematic Code Description

Code	Description
Unconventional ITG	The sentiment represents an unconventional ITG process that is not described in the COBIT 5 guidelines. This has to do with roles and responsibility, accountability, decentralisation of authority and distribution of decision making.
Conventional ITG	The sentiment leans towards a conventional ITG process that is mentioned in COBIT 5 guidelines. This can be found in Chapter 2, section 2.4.4.
Ambiguous	This code refers to sentiments that are mixed (conventional and unconventional governance) or neither.

Ultimately the responses amounted to 70 unique answers that are attached in Appendix B, and the summary results are discussed in section 6.3. These results were carefully reviewed, organised and indexed according to codes that represent common themes. The researcher read and reviewed all 70 answers and made comments to each, this detailed interpretation can be found in Appendix C. The coding process was repeated several times in order to finetune the codes into three high level themes.

6.3. Questions & Results

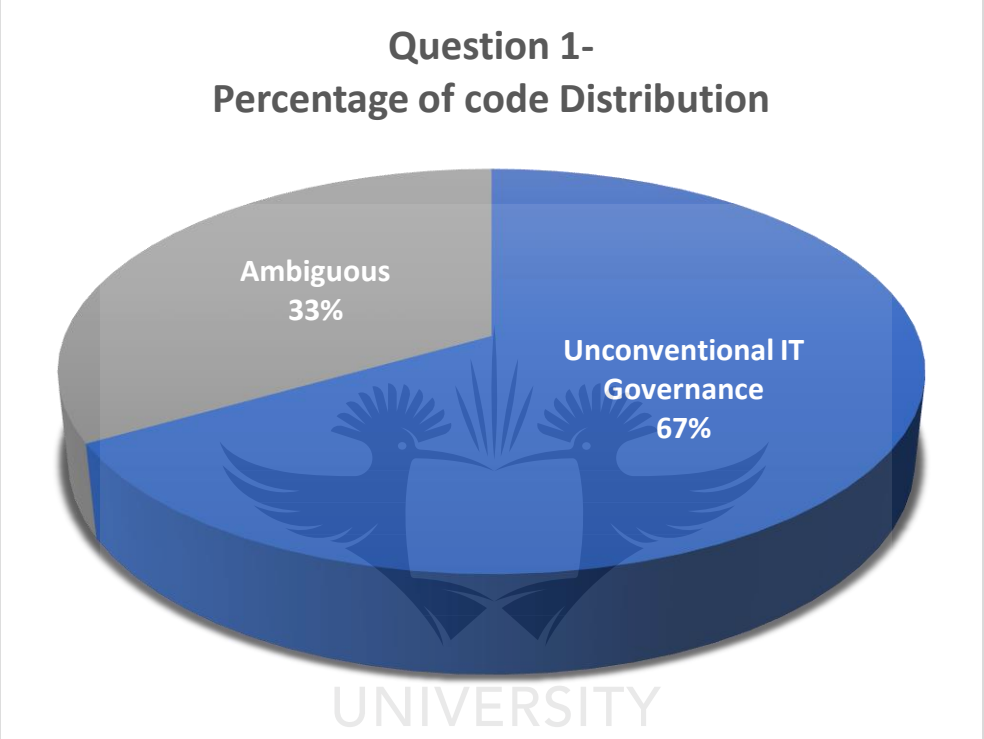
The questionnaire consisted of seven questions and was distributed to over 50 participants over a period of two months. Due to the research being a cross sectional study, the first 10 respondents were used. The questions and their respective results are as follows:

I. Question 1

This question aims to establish how a conventional governance practice like programme creation would be dealt with in a DAO theoretically. Depending on the organisation, a programme director can be part of the board of directors or work outside of the board. This practice under the COBIT 5 Process EDM01- Ensuring Governance Framework Setting and Maintenance. The question is:

"In hierarchical organisations, boards often appoint programme managers who create and implement IT Programmes. These outline the processes of managing several related projects, often with the intention of improving an organisation's performance. How do you think a programme would be implemented in a DAO, and would a director be responsible for that?"

Figure 6.2: Results of Question 1



Data Presentation:

The results of this question reveal that there is a dominant notion of unconventional Governance when it comes to EDM01. Most of the responses included hypothetical ideas of what would occur if a programme manager was appointed in a DAO. Several respondents mentioned that individuals in the network could still appoint and MD or program manager but that it should be a democratic and decentralised process. However, based on the case study research on DAOStack, there is no explicit rule on programme management within a DAO.

Inference:

The data implies that improving an organisation's performance through the use of programme management will require unconventional governance practices.

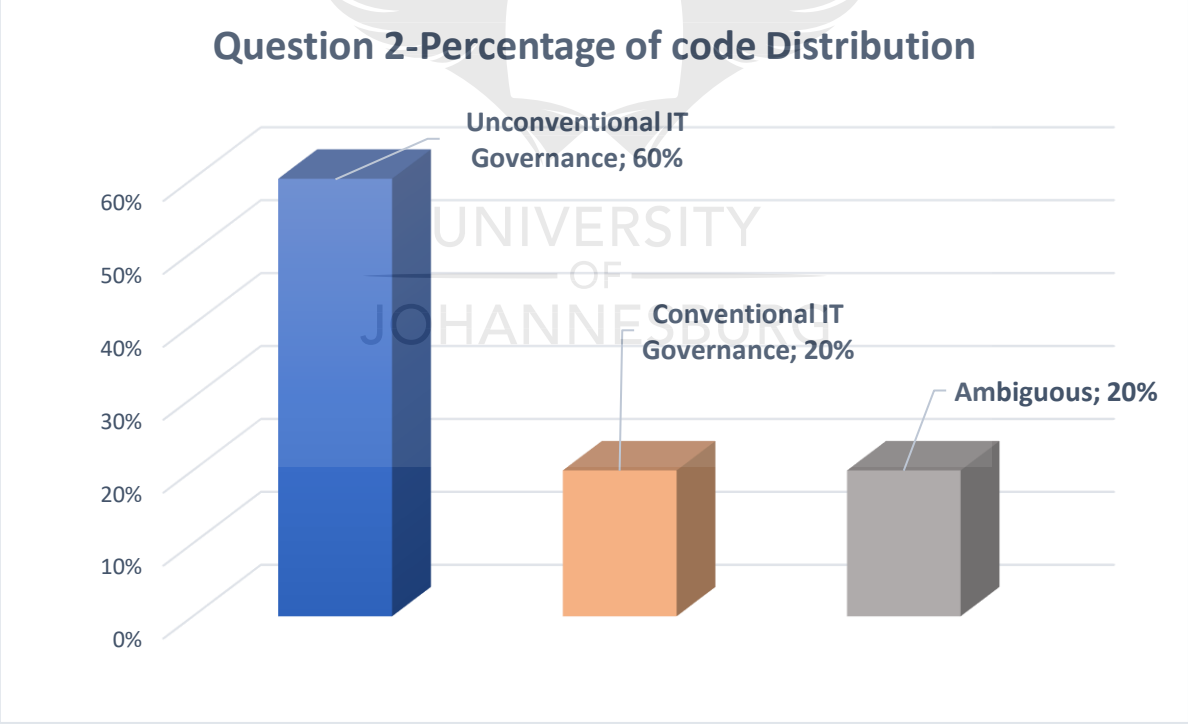
Despite this dominant theme, there seems to be a significant amount of ambiguity and uncertainty from the subject matter experts on this topic. 33% of the responses indicate that the respondents are unsure about the responsibilities of a programme manager in a decentralised autonomous organisation. This implies that it may not be necessary to have programme managers or that this is a challenge that has not yet been identified.

II. Question 2

This question aims to understand the steps that a director would have to follow to achieve goals outlined for process EDM01 in table 6.1. The objective of this question was to assess whether participants believe directors would follow conventional governance guidelines in DAOs. The question is as follows:

"How would an IT director in a DAO ensure that the main governance protocol is maintained?"

Figure 6.3: Results of Question 2



Data Presentation:

The results of question two reveal a dominant notion of unconventional governance (60%). Although unconventional governance is the strongest theme here, it appears that a certain degree of conventional governance is expected for EDM 02, ensuring

that the governance protocol of a DAO is properly maintained. Similar to question one, these results also indicate 20% level of uncertainty or ambiguity surrounding this governance process.

Inference:

This data implies that

a) There is still a significant amount of uncertainty and conflicting views on governance in DAOs.

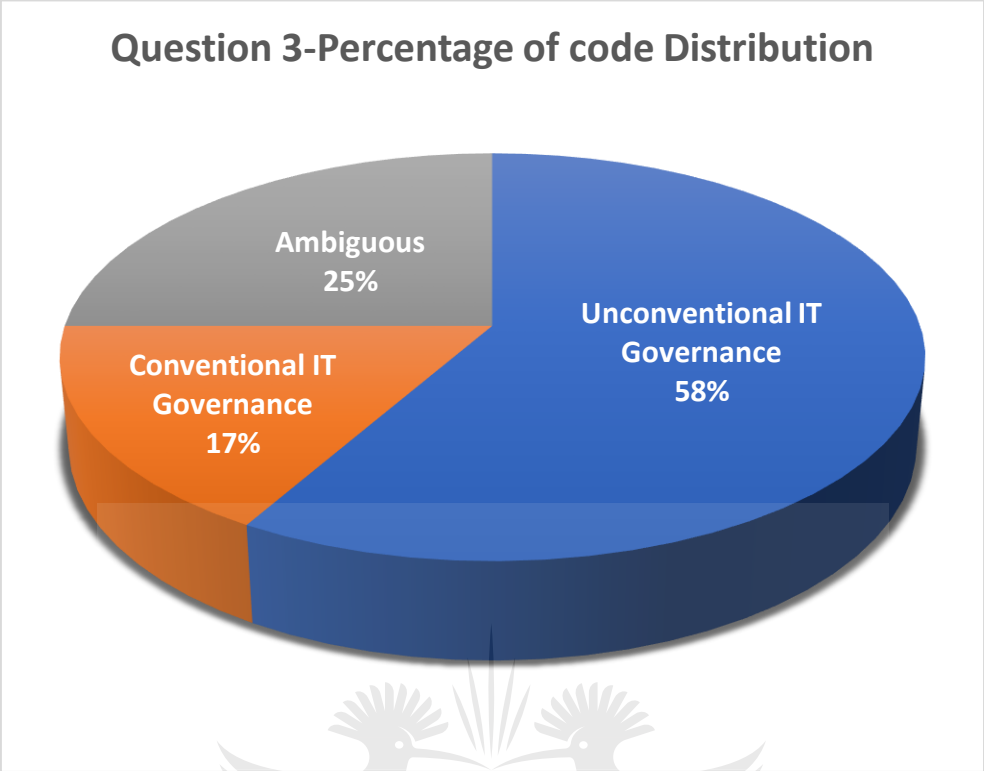
b) The implications of blockchain on governance is extensive and has not yet been fully unpacked or explored for most. However, there are expectations that a community of members in a DAO would collectively assume the responsibility that a director in a hierarchal organisation would. It appears that decision rights, incentives and accountability are radically divorced from conventional governance models.

III. Question 3

This question was centred on ensuring benefits delivery, process EDM02. The aim was to assess how participants believe directors would plan for and control company benefits, using the example of return on investments in a DAO. The question was:

"How do you think an IT Director can/should secure optimal value of the hardware and software of DAOs? E.g. If the members of a DAO vote to invest on scaling the network which will require more processing power and new servers… would a director measure the return on investment privately?"

Figure 6.4: Results of Question 3



Data Presentation:

In these results 58% of the sentiments were associated with unconventional governance. It is clear that the dominant sentiment from respondents is that unconventional governance practices are required for optimising the hardware and software. Suggestions included absolute transparency and giving all members of a DAO access to data that would otherwise be confidential in hierarchical organisations. Some respondents made suggestions of using cloud storage, which is a conventional practice but the application of it unconventional. There were also some uncertainties in the responses.

Inference:

The data implies that there are different ways of securing value in DAOs and it is largely dependent on the creators and participants' decisions. It appears governance is acutely flexible in this regard. This falls in line with the principles of DAOStack that advocates for a decentralised yet community governance organisation.

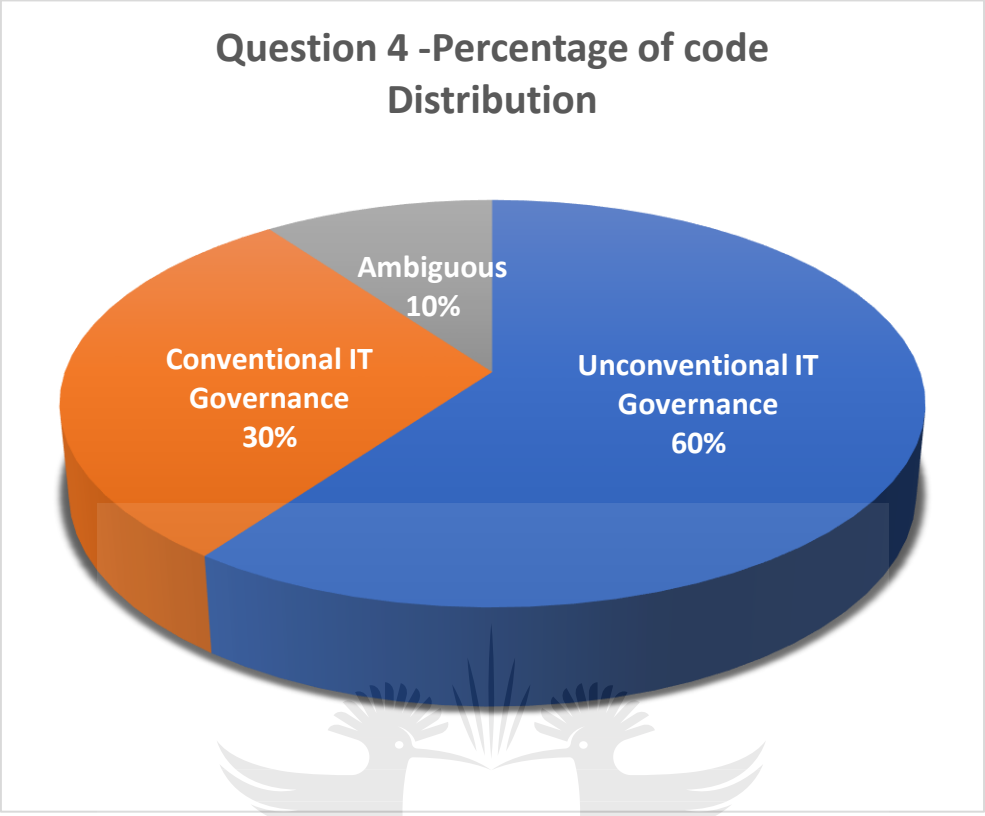
It would be fair to say that the optimising the hardware and software in a blockchain has no definitive processes and that it depends on several factors. These factors could include use cases and the mandates between members of the DAO.

IV. Question 4

This question addresses one of the commonly debated aspects of Blockchain technology, decentralisation. The question aims to establish whether participants believe certain information would theoretically be kept private by a director in order to support the business. Information is a vital business asset and a key part of a CIO's role is to form information security strategies that protect the organisation (Tharakan, 2016). The question was:

"Would a director in a DAO keep a private and accurate ledger of costs and estimated benefits that will support the business?"

Figure 6.5: Results of Question 4



Data Presentation:

The results of this question show that unconventional governance is preferred and expected when it comes to the accessibility of financial information. This is evident with more than half of the respondent's vouching for a public ledger of costs. 60% of the overall sentiment is that costs, invoices and any payment related data should be accessible to all members of the DAO.

Inference:

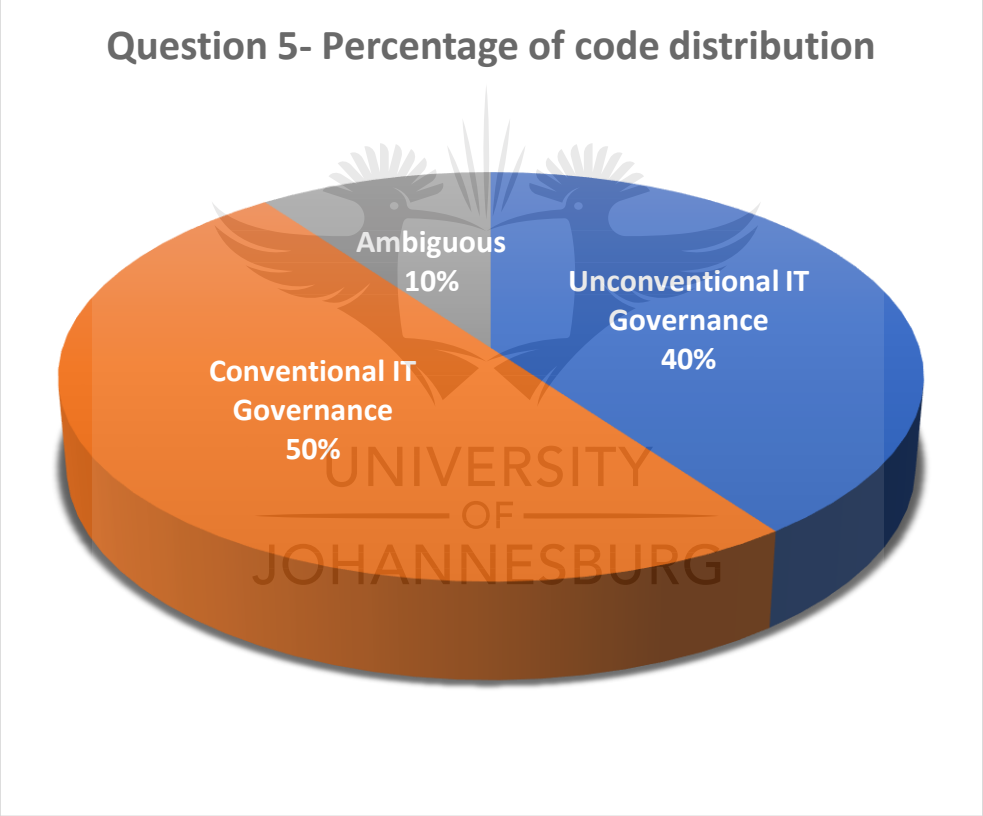
It is still clear that there is no single way to enforce governance in DAOs. Most respondents believe it is up to the peer to peer community to decide what is private and public. The dominant theme implies that it is unnecessary to have a single authority to oversee and control costs. In saying that, one cannot ignore that 30% of the sentiment leans towards conventional governance practices. This could imply that the first and foremost aspect of running a business on blockchain is to accept that some degree of centralisation is necessary when initialising a DAO and that ensuring a sound governance protocol is a key aspect of enforcing fairness and transparency. These two aspects are synonymous with conventional governance.

V. Question 5

Question five addresses EDM05 and EDMO02. It aims to discover how the needs of stakeholders would be met in a business that runs as a DAO. As well as the types of controls that could be used to facilitate decision-making. The objective was to identify whether the answer differs to conventional ways of managing stakeholders in hierarchical organisations. The question was:

"How would a director measure the level of stakeholder satisfaction in a DAO? Are KPIs implemented into the System? If so, would this be stored privately?"

Figure 6.6: Results of Question 5



Data Presentation:

These results show that 50% of the sentiment leans towards conventional governance. A lower but significant 40% of the overall sentiment reveals nuances of unconventional governance. The over-arching notion of the responses indicate that a certain degree of conventional governance will inevitably take place when assessing stakeholder satisfaction. This being due to the human-centric and case by case nature of stakeholder management.

Inference:

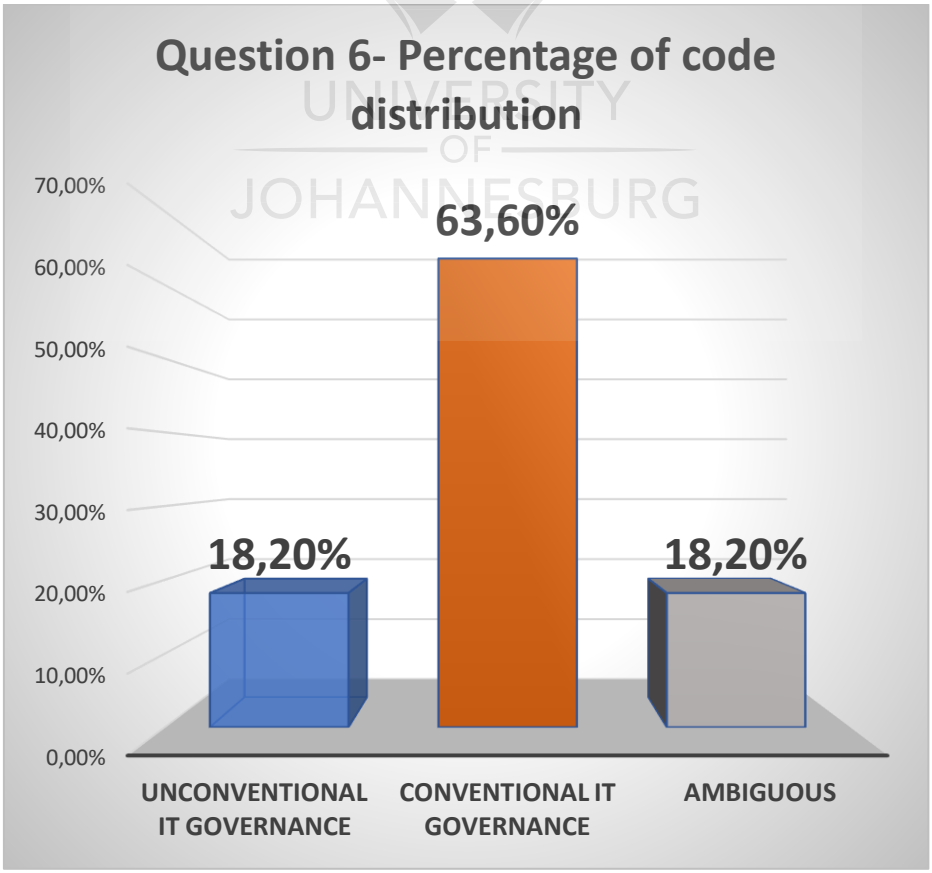
Contrary to most of the answers, this topic reveals a stronger theme of conventional governance. It re-enforces the fact that governance is a complex discipline. It indicates that governance in a DAO has a middle ground between unconventional and conventional practices. It suggests that running a business regardless of a type of technology used might still require traditional governance approaches.

VI. Question 6

This question addresses EDM03 – Ensuring risk optimization. The purpose of this question was to ascertain whether IT directors would use similar methods and processes to manage risk and whether that would be their responsibility entirely. According to ISACA, owning IT risks and giving direction for managing key risks are fundamental aspects of ITG (Hardy, 2005). However, DAOs are proving to challenge that. To determine that, the question was:

"How would an IT director ensure that risks are mitigated in DAOs? Is it their responsibility alone? E.g. a 51%Attack, or a Hard Fork"

Figure 6.7: Results of Question 6



Data Presentation:

The data reveals a dominant theme (64%) of conventional governance practices. Most participants suggest that risk specialist or blockchain auditors would be appointed to address security risks such as the ones mentioned in the question. 18% of the overall sentiment reveals ambiguity or uncertainty and another 18% indicates that unestablished governance approaches could be invented and applied to assess risk issues. Some respondents suggested that the risk is spread across a blockchain network and other reinforced that by advocating that risk is a collective responsibility.

Inference:

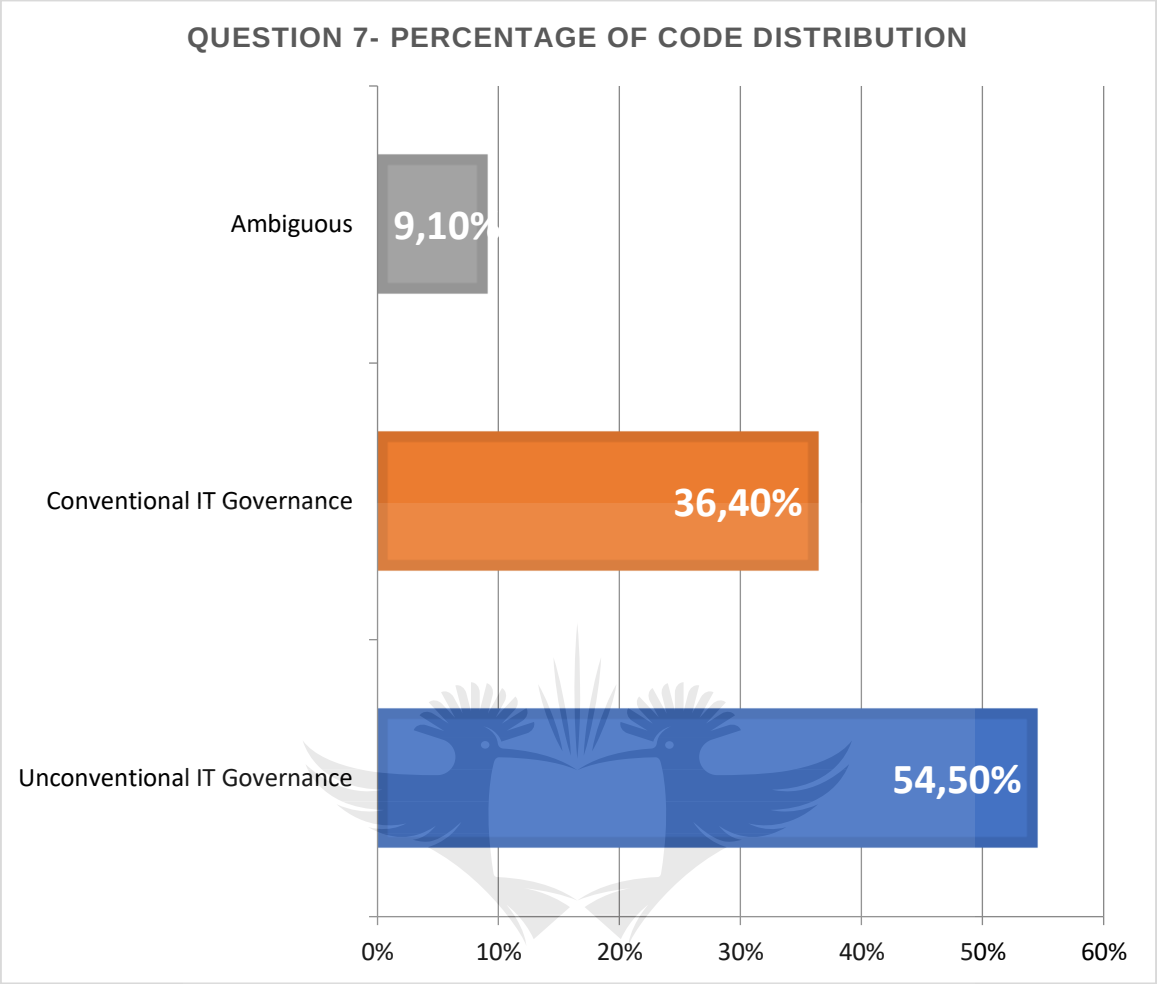
It appears that when it comes to risk mitigation, a major theme is that the same hierarchical governance approach applies. Some of the responsibilities that are traditionally assigned to CIOS are assigned to DAO participants for this process. There is still a small amount of ambiguity and uncertainty, thereby indicating that there is no definitive way of managing risk, and no explicit rule on who should manage risk in a DAO.

VII. Question 7

The last question supports EDM03 and EDM04. It aims to address how resources can be optimised to help secure the organisation and how to mitigate the risk of human resources abusing information or processes within the organisation. The question was:

"It is expected that in some DAOs, agents will work remotely, and virtual teams will exist. This could be seen as a recipe for disaster by those who prefer to work with others in person. E.g. The DAO Hack in 2016 was the cause of an anonymous agent in a DAO who manipulated a smart contract to leak millions of funds. How could IT directors this be prevent these types of risks in DAOs?"

Figure 6.8: Results of Question 7



Data Presentation:

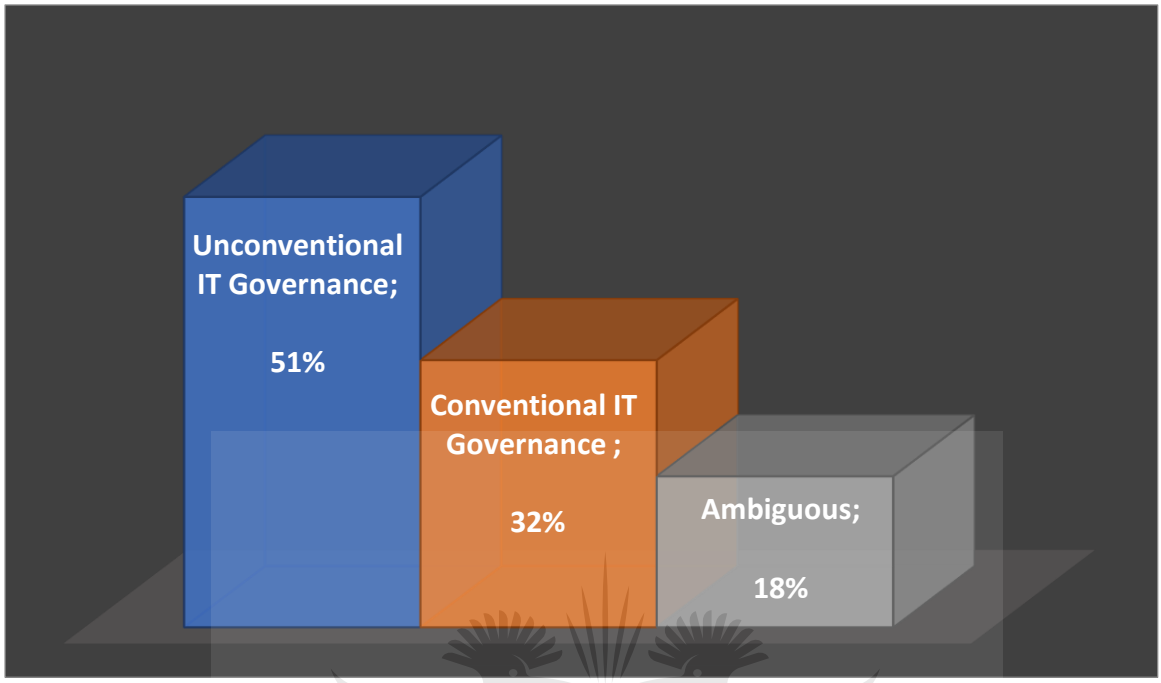
The results of this question reveal a dominant theme (55%) of unconventional governance. However, there are subtle mentions of conventional governance practices (36%) and a smaller percentage (9%) of ambiguity or mixed sentiments. Respondents made mentioned of new processes like Know your Colleagues (KYC), and some were adamant that directors should be responsible for assessing risk.

Inference:

Interestingly, this question addressed similar areas of governance to the previous one, yet the dominant theme in this one is unconventional governance. The outcome of this question reveals vast contradictions among experts. The logical inference is that there are numerous ways of practicing risk management in a DAO, and conventional governance could be an option.

The overall code distribution for all questions is depicted in Figure 6.9

Figure 6.9: Overall Distribution of Codes



The results reveal a majority sentiment of unconventional ITG . Although experts do think DAOs would require conventional governance processes in some areas, specifically in managing risk and stakeholders, all other areas of governance would require processes that are not outlined in COBIT 5. This includes the decentralisation of information repositories, decision making and the distribution of authority to groups of random individuals.

6.4. Challenging Opposing Views

In Chapter 4, the importance of intellectual integrity was highlighted and explained. In line with the selected research approach, and to maintain an unbiased view on the phenomena, several opposing views were identified and explored to challenge the main perspective and allow for critical thinking. In addition to some of the opposing views shared in the questionnaire results, Appendix B, the following are opposing ideas that challenge the hypothesis.

One of the most opposing views was received as an email response from an invited participant. The participant, an author of a book on Bitcoin, did not to complete the questionnaire but has publicly claimed that there is no such thing as Blockchain. The author suggested the researcher read his book to understand this statement. The

researcher took that as opportunity to explore this opinion. In summary, the author argues that Blockchain has no real value without Bitcoin. The last chapter of the book explains why Blockchain is unlikely to offer economic advantages for any commercial problem other than the one it was specifically engineered to solve, digital cash.

Critics of the author's book on Amazon (Light, 2018) have argued that while the author demonstrates a clear understanding of Bitcoin, in the tenth chapter he seems to misconstrue of the meaning of public, private, or permissioned Blockchains and how the latter may be more useful than a centralised database in some cases (Light, 2018).

Along with other online and offline debates, it is evident that there are many polarised views on this topic. Although they are not included in the primary data of this dissertation, the researcher has brought forward these topics at conferences, panel discussions and online forums (The DAO Hub, 2018; ISACA Engagement Forum, 2018; Blockchain Africa Conference, 2018) in an effort to gather more insight and perspective.

Overall, it appears that certain groups of people are adamant that Blockchain will revolutionise many sectors of the global economy (CSIR, 2018; Mougayar & Buterin, 2016; Swan, 2015; Tapscott ,2015), while others believe Blockchain is not clearly defined which makes it is difficult to identify the value it brings (Jeffries, 2018; Ammous 2016).

Much like the author who claimed Blockchain did not exist, it must be mentioned that critics have been known to use technical ambiguities to justify the notion that Blockchain is improperly defined, thus serving as the main argument against what is generally understood to be Blockchain. The subject matter continues to spark a range of discussions and some critics express a contentious opinion in order to provoke debate or test the strength of the opposing arguments (Avital et al., 2016).

Despite the opposing views and debates on Blockchain, there is still a growing increase in the experimentation of the technology around the world. In South Africa, a consortium of leading banks formed a distributed ledger system for interbank clearing, this was called Project Khoka (SARB 2018). As described in Chapter 3, International banking consortium R3 is proactively enforcing the technology to achieve efficiency in record keeping between banks and execution of institutions' financial agreements (R3,

2018). These are only but a few examples of large multinational corporations experimenting with Blockchain.

6.5. Analysis of the COBIT RACI chart

To thoroughly exhaust the analysis process of this chapter, this section aims to further highlight the disparities within COBIT's IT governance framework in relation to the ideas that have been expressed in the questionnaire and the case study. The objective is to provide enough context from which recommendations can be made.

Although COBIT 5 is a good-practice framework that provides an end-to-end guideline of ITG, there are certain inconsistencies that have already been identified through other research (Catarino, Fragoso, Da Silva, & Vasconcelos, 2016). These inconsistencies lie between the roles' assignments which are defined in the assignment's matrix charts of COBIT 5 (RACI). It is also acknowledged by other researchers, that COBIT is impractical and not easy to understand (Zhang & Le Fever, 2013).

One of the main reasons why COBIT is impractical is that it does not provide suggestions on how to customise the framework for a unique environment (Zhang & Le Fever, 2013), and a DAO is an exceptional untapped environment. In addition to this, there are currently no proven studies or statistics confirming the advantages of COBIT in Blockchain based companies. Moreover, as other research has shown, the RACI charts is not a "one size fits all", as different organisations have different structures and may assign certain responsibilities to different individuals (Zhang, 2013; Catarino, et al., 2016).

These inconsistencies not only lead to the inaccurate definition or roles and responsibilities in an organisation but could ultimately lead to ineffective ITG (Catarino, Fragoso, Da Silva, & Vasconcelos, 2016).

Although ISACA has a disclaimer in COBIT 5, stating that readers should apply their own professional judgement to their educational resource (ISACA, 2012), they sell courses and provide certifications based on this content. These certificates claim to make professionals more employable and give them proven experience so that they are capable of bringing IT Governance into an organisation (ISACA, 2012). However, there is no mention of decentralised autonomous organisations.

With this in mind, the researcher chose to go one step further to point out the gaps in the COBIT's RACI Chart in relation to Blockchain companies. Each EDM process is analysed to assess the role of CIOs. For this analysis, the role of CTO is excluded because COBIT does not provide a clear distinction between this role and what it calls the head of IT operations (ISACA, 2012). Depending on how an enterprise arranges its board, the head of IT operations may or may not be an official director (ISACA, 2012). Nonetheless, the analysis of CIO is assessed in the following section.

6.5.1. RACI charts

To provide background to the reader, the following is a brief definition of a RACI chart and its purpose;

RACI is an acronym that stands for responsible, accountable, consulted and informed (Kantor, 2018). The Chart is a matrix to achieve the most effective definition and documentation of roles and responsibilities in an organisation or in a project (Haworth, 2018). The RACI chart also contains various organisational structures that can be further elaborated in different parts of an organisation's policy or mandates (COBIT, 2012).

Definitions of the RACI Categories

- Responsible: the individual who performs the process or task.
- Accountable: the individual or group who holds accountability. They have the authority to approve, disapprove or veto a decision.
- Consulted: the individual that needs to feedback and contribute to the process or task.
- Informed: the individual that needs to be informed of decision or actions. This is one-way communication.

In Table 6.4, the CIO is responsible for evaluating, directing and monitoring the governance system. So far, this study has established that in DAOs this responsibility is distributed to a community within a network. The RACI charts associate responsibilities to roles, however role assignment in DAOs are not denoted in this way. Therefore, this chart would not be useful or applicable in a DAO.

Table 6.4: EDM01 RACI Chart

EDM01 RACI Chart																										
Key Governance Practice	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
EDM01.01 Evaluate the governance system.	A	R	C	C	R		R				C		C	C	C	C	C	R	C	C	C					
EDM01.02 Direct the governance system.	A	R	C	C	R	I	R	I	I	I	C	I	I	I	I	C	C	R	C	I	I	I	I	I	I	I
EDM01.03 Monitor the governance system.	A	R	C	C	R	I	R	I	I	I	C	I	I	I	I	C	C	R	C	I	I	I	I	I	I	I

Table 6.5 demonstrates that CIOs should be responsible for the evaluating, directing and monitoring optimisation of resources. This process formed part of question 3 the questionnaire, where 58% of the sentiments revealed unconventional ways of performing value optimisation, with an emphasis of community management and open cloud computing and storage. This table indicates that only one individual is responsible for these processes. This contradicts the approaches that were described in the DAO case study. Thereby confirming that there are new ways of assigning responsibilities in an organisation which are not demonstrated in COBIT5. This validates the notion that current ITG frameworks have gaps. These gaps, if identified by ISACA, could be addressed and spark the modernisation of governance.

Table 6.5: EDM02 RACI Chart

EDM02 RACI Chart																										
Key Governance Practice	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
EDM02.01 Evaluate value optimisation.	A	R	R	C	R		R			C	C		C	C	C	C	C	R	C	C	C					
EDM02.02 Direct value optimisation.	A	R	R	C	R	I	R	I	I	I	I	I	I	I	I	I	I	R	C	I	I	I	I	I	I	I
EDM02.03 Monitor value optimisation.	A	R	R	C	R		R			R	C	C	C	C	C	C	C	R	C	C	C					

Table 6.6: EDM03 RACI Chart

EDM03 RACI Chart																										
Key Governance Practice	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
EDM03.01 Evaluate risk management.	A	R	C	C	R	C	R			I	R	C		I	C	C	C	R	C							C
EDM03.02 Direct risk management.	A	R	C	C	R	C	R	I	I	I	R	I	I	I	C	C	C	R	C	I	I	I	I	I	I	I
EDM03.03 Monitor risk management.	A	R	C	C	R	C	R	I	I	I	R	R	I	I	C	C	C	R	C	I	I	I	I	I	I	C

Table 6.6 highlights the risk management processes and specifies that the CIO is responsible for all three. As mentioned in the DAO Case Study and highlighted several times in the questionnaire data, there is often no single party responsible for risk in a DAO. The management of risk is distributed to all members of the blockchain network.

Table 6.7: EDM04 RACI Chart

EDM04 RACI Chart																											
Key Governance Practice	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
EDM04.01 Evaluate resource management.	A	R	C	C	R		R			I	C	C	C	C	C	C	C	R	C	C	C					
EDM04.02 Direct resource management.	A	R	C	C	R	I	R	I	I	I	I	I	I	I	I	I	I	R	C	I	I	I	I	I	I	I
EDM04.03 Monitor resource management.	A	R	C	C	R	I	R	I	I	I	C	C	C	C	C	C	C	R	C	C	C	I	I	I	I	I

Table 6.7 and 6.8 reveal that CIOs are expected to take full responsibility for resource and stakeholder management. Each of these processes, as outlined by the case study and questionnaire results are not entirely applicable in DAOs. In DAOs, the processes are transcribed into governance protocols and stakeholders are integrated into the system.

Table 6.8: EDM05 RACI Chart

EDM05 RACI Chart																											
Key Governance Practice	Board	Chief Executive Officer	Chief Financial Officer	Chief Operating Officer	Business Executives	Business Process Owners	Strategy Executive Committee	Steering (Programmes/Projects) Committee	Project Management Office	Value Management Office	Chief Risk Officer	Chief Information Security Officer	Architecture Board	Enterprise Risk Committee	Head Human Resources	Compliance	Audit	Chief Information Officer	Head Architect	Head Development	Head IT Operations	Head IT Administration	Service Manager	Information Security Manager	Business Continuity Manager	Privacy Officer
EDM05.01 Evaluate stakeholder reporting requirements.	A	R	C	C	C	I										C	C	R	I			I				
EDM05.02 Direct stakeholder communication and reporting.	A	R	C	C	C	I										C	C	R	I			I				
EDM05.03 Monitor stakeholder communication.	A	R	C	C	C	I										C	C	R	I			I				

6.6. Recommendations

At this point, it is clear that Blockchain enables secure exchange of value without the need for a third-party authority (Schweinitz & Ferr, 2018) , therefore it is expected that sectors fuelled by record keeping and verification will be disrupted.

A Gartner report (2018) indicates that although 91% of directors have heard of Blockchain, they do not necessarily have a clear understanding of its implications. The report also reveals that 36% believe Blockchain provides a great opportunity and 21% see it as a threat (Panetta, 2017). Moreover, an ITG framework like COBIT is not practical when applied in decentralised organisations. Research has revealed that COBIT's actual utilisation and effectiveness is not clear due to the lack of academic studies and the proliferation of other IT Standards (Zhang & Le Fever, 2013).

To ease the learning curve for individuals venturing into blockchain and to provide a basis for further research, the following three recommendations have been made:

- The COBIT Framework could be extended to provide guidelines for DAOs, as evidently the RACI charts and the EDM processes are more suited for traditional hierarchical governance.
- Boards should begin practising influence-oriented governance as opposed to the traditional control-based approaches in order to prepare for the fourth industrial revolution.
- CIOs are encouraged to keep observing their surrounding ecosystem for improvements in processes and disruptions that may affect their business. They can start by investing in research and development of emerging technologies at their organisation. Blockchain will especially affect the supply chain industry, payments, public sectors and any other industries that rely heavily on information or digital assets.

6.7. Conclusion

A number of critical factors were covered in this chapter that have led to this conclusion. The chapter covered the steps taken to prepare the data collection process, it provided clear and succinct data, including the summarised and detailed versions (in Appendix B and C). It also detailed the technique used to analyse and interpret the data. Without these factors it would have been difficult to generate recommendations.

A fundamental part of this chapter was the data collection. The online questionnaire was distributed to participants who fit the research criteria. Ten of those participants completed the questionnaire anonymously and the results were coded by theme and summarised. The data was administered using two tools; 1- TypeForm, and online platform that specialises in dynamic form questionnaires and 2- QDA Miner, a data analysis program designed to assist researchers in managing, coding and analysing qualitative data.

A qualitative approach was most suitable for the data collection as it provided deep insight into the human experiences and observations, it also allowed the researcher to explore the theoretical effect of decentralisation.

This chapter was central to the dissertation and necessary in delivering a logical and sound argument that supports the hypothesis. The findings, extrapolated from the experts' insights, the critical analysis of opposing views and the literature studies, revealed that conventional IT Governance is not suitable for DAOs. This confirms that the use of blockchain technology is giving rise to new governance models, which coincides with research from Gartner on how Blockchain will impact boards (Panetta, 2017).

7. Chapter 7 – Conclusion

7.1. Introduction

This study was intended to not only demystify Blockchain technology but explore its implications on ITG. The aim was to identify the impact that Blockchain technology could theoretically have on governance disciplines by examining the roles and responsibilities of directors in hierarchical organisations and contrasting them to those in Decentralised Autonomous Organisations (DAOs). It was important to establish whether the research findings corroborate or invalidate the notion that Blockchain will disrupt money, business, economics and governance (Swan, 2015; Tapscott 2016; Mougayar & Buterin, 2016).

The research was an empirical qualitative, inductive and cross-sectional study of the governance processes in Blockchain organisations. The primary data for this research was attained through a questionnaire and the secondary data was collected through single case study on a Blockchain operating system designed for collective intelligence. The research included two literature reviews, the first on ITG and the second on Blockchain technology.

To successfully examine the impact of a modern technology, an inductive approach was applied as it allowed the researcher to develop a theory through observations of the empirical word. Furthermore, it was necessary to apply inductive reasoning as there are few prior theories or explanations on this subject matter. However deductive reasoning was applied to certain aspects of the research that have already been conceptualised and written in theory, such as COBIT's ITG processes.

After collecting and analysing data, the main premise emerged. The premise being that conventional ITG cannot be applied squarely into Blockchain based organisations, from this premise one can deduce that ITG is impacted in various ways by Blockchain. This is elaborated on in the conclusions section of this chapter.

The general aim of this chapter is to highlight how the research objectives were achieved and to provide answers to the research questions outlined in Chapter 1.

The remainder of this chapter revisits the research problem as laid out in Chapter 1, then stipulates the conclusions and reasoning for them, it then highlights the research limitations, provides recommendations for further research and finally describes the contribution that this study has had to the IT industry.

7.2. Revisiting the Problem

The goal of this research was to develop a sound inductive hypothesis that substantiates the aforementioned premise. To pursue this goal, the research needed to meet certain objectives. The following is a list of the research objectives and a description of how they were met.

7.2.1. Objective 1

The first objective was to explain how IT governance works, and what conventional frameworks look like. The first literature review, Chapter 2, examined three different frameworks and guidelines for governance. This included ITIL, COBIT and ISO27002. For the remainder of the research, COBIT; one of the most popular guidelines (Mohr, 2011; Tittel & Kyle, 2018) was used as the main frame of reference.

7.2.2. Objective 2

The second objective was to explain what Blockchain technology is. This was achieved by demystifying some of the technical concepts in the second literature review, Chapter 3. The literature review covered the different layers of Blockchain using the example of Bitcoin. It also explored the origins of the technology and how it has evolved into Blockchain 2.0, smart contracts and Blockchain 3.0, a new model for organised activity. The study demonstrated that up until now – 2018, there have been very few applications in the category of Blockchain 3.0. This is important to consider because this research applies mostly to this category. Thus, the hypothesis will certainly require further testing as society evolves and more organisations begin to adopt the technology.

7.2.3. Objective 3

The third objective was to conduct a case study on an existing Blockchain application that challenges conventional governance and to identify patterns that could substitute ITG processes as outlined by COBIT 5.

This objective was achieved through the case study in Chapter 5. This case study demonstrated how an operating system for collective intelligence has created ways to automate decision making, including some of the typical decisions that a CIO or CTO would make. The case study laid out various DAO Topologies, explained the decentralised model of proposals and voting and how consensus can be achieved using governance protocols.

7.2.4. Objective 4

Some of the conventional governance processes as outlined in COBIT were proven to be possible in a DAO. This was depicted in a comparative analysis of factors that contribute towards decision making in hierarchical organisations versus in DAOs.

However, despite having found that certain governance processes could be automated, there were aspects of decision making that were considered to still require tacit and organisational knowledge from an experienced individual. This would be difficult to achieve in a DAO with virtual teams.

7.2.5. Objective 5

The final objective of this research was to identify the impact that Blockchain could theoretically have on ITG in the future. This was achieved by combining the primary data collected, the case study, as well as the literature reviews together and analysing this information to confirm the hypothesis. To establish impact, a list of ITG processes from COBIT 5 were used as measurement indicators. This is explained further in the next section.

7.3. Conclusions

This section draws inferences from the culmination of data and analysis performed in this study, and in relation to research questions. As mentioned in the research and methodology chapter, an inductive study begins with no hypothesis, but a proposed theory (Singh & Nayak, 2015). The researcher must then provide substantial findings to confirm the proposed theory, which can only be done when the study is complete (Bruce, 2007).

After collecting and analysing data, the main premise emerged. The premise is that conventional IT governance does not fit squarely into DAOs. Having said that, it is

important to note that the conclusions in an inductive argument is at best probable if a strong inference from the premise is made (Steup, 2005).

The conclusion of this study is that there is a strong probability that the discipline of ITG will be impacted by Blockchain should it become more widely adopted. There are sufficient reasons that governance institutes like ISACA, ITIL and the ISO should extend their frameworks to include new models of governance that encompass DAOs.

However, given that DAOs are still at their infancy, it will take a reasonable number of years before this impact is felt fully in the IT industry. Nonetheless, it is clear from the evidence provided that corporate governance is facing a progressive disruption.

This inference is based on the following:

1. The majority of responses from the questionnaire confirm that an unconventional IT governance process is required in Blockchain based organisations. This is supported by the case study and Blockchain literature reviews.
2. The emergence of Blockchain platforms like Ethereum, R3, EOS, NEO, DAOStack, and eInc as referenced in Chapter 2 and Chapter 5 proves that decentralisation is a growing trend that has plausible effects on different professions. Ethereum is the largest operating system featuring smart contract functionality that hosts more than 2000 decentralised applications. The number has steadily grown since its launch.

7.4. Strength of the chosen Research Design

Chapter 4 highlighted the chosen research design and it served as the basis for the theoretical framework of this dissertation. Throughout the study it was imperative to critically asses the proposed theory using different methods. These methods included using opposing arguments to stimulate critical thinking, using triangulation in the data analysis and repeatedly reviewing and analysing the evidence holistically. These processes were time consuming but strictly followed to ensure the research maintained intellectual integrity. Given that the research was inductive, the researcher needed to tread carefully before forming the hypothesis. This was subsequently confirmed with the results of the questionnaire and knowledge gained from the case study on DAOStack.

The choice of epistemology was a well-suited philosophy for this study because it positioned the researcher to explore what is known to be true and how knowledge can be formed, disseminated and communicated (Datt, 2016). An intrinsic element of epistemology was used diligently in the analysis. This element is interpretivism.

Due to the nature of qualitative studies, it was most appropriate to select interpretivism because it advocates the understanding of differences or similarities between humans in their roles as social actors (Singh & Nayak, 2015). Interpretivism is based on how one interprets social roles in accordance with the meaning one gives to these roles. This philosophy allowed the research to be exploratory, which supports the goal of discovering the possibilities of this modern technology.

7.5. Research Limitations

While every effort was made to provide strong research, there have been limitations that must be declared and discussed. The limitations to this research are the following:

7.5.1. Limited sampling

While the data collected and analysed was valuable, investigating a larger sample could have yielded stronger results. Yet, this would be a challenging task for any researcher at this stage as there is a lack of subject matter experts who possess both corporate governance and Blockchain knowledge and experience (Gartner, 2018).

7.5.2. Cross sectional time horizon

The time constraint was an inevitable shortcoming but a noteworthy one, nonetheless. This empirical study reflects the state of Blockchain technology at a particular moment in time. Although this chosen method of study provided theoretical answers to the research questions, it did not provide quantitative data that proves that Blockchain has a scientific and a measurable impact on IT governance.

In saying that, it must be mentioned that governance itself is not simple to measure quantitatively. According to a study at the University of Cambridge (Schnyder, 2012) measuring governance is extremely complex, and while methodological efforts and innovations are laudable, they will remain pointless as long as new methodological approaches are applied to fundamentally flawed measurements. Thus, a longitudinal approach could offer better results to examine to the long-term effects of the technology on corporate governance.

7.5.3. Lack of existing quantitative data

Another significant shortcoming was the lack of quantitative data on this topic. This weighed heavily on the decision to opt for a qualitative study instead.

The phenomenon in this research is futuristic and theoretical. It is predicted to affect various sectors of the economy in the future (Swan, 2015; Mougayar & Buterin, 2016). For instance, the thought experiment in Chapter 5 that spoke about autonomous taxis in the year 2050, where leaderless organisations will become prevalent. Another example is the prediction that by 2030, most of world trade will be conducted leveraging Blockchain technology (Valde & Mitselmakher, 2018).

It is challenging to gather quantitative data when the phenomenon will likely occur in years to come. This is a significant limitation to this cross-sectional study because it means the researcher must rely upon qualitative data to confirm the hypothesis. Hence the research design was formulated to support an inductive style of reasoning.

7.6. Recommendations for further research

This research proves that there are epistemological issues surrounding the nature and scope of knowledge of Blockchain technology. These issues are a result of the coupling between the physical and virtual domains, where the relationship between the two variables is unconfirmed (Swan & De Filippi, Toward a Philosophy on Blockchain: A Symposium, 2017).

One of the challenges in establishing correspondence between these two domains is due to the different natures of these two worlds: the virtual world is quantitative (digital ones and zeros), and the physical world is qualitative (chaotic, variable, irrational) (Swan & De Filippi, 2017).

With a lack of widespread knowledge on these ideologies, there are a limited existing guideline on the implications of Blockchain on ITG, particularly for roles like CIO and CTO.

In due course the experimental process to identify the computational equivalents of human-based qualities such as ethics, trust and truth, will continue. With that being said, it is recommended that further research projects address the following areas:

- Framework designs for effective DAO governance.

- Longitudinal study of the advantages and disadvantages of DAOs.
- The adjustments of IT governance frameworks and certifications to include decentralised business models.
- The need for a formal certification that focuses on decentralised business models.

7.7. Contribution to the Industry

Notwithstanding the research limitations, this study has been a uniquely useful contribution to the IT industry because there currently very few studies that focus on this topic.

One of the aims of this research was to build a new theory. With the help of subject matter experts, the findings help shape and substantiate the ideology of modern governance in the fourth industrial revolution. This research can be used as a platform for further research or as a guideline for individuals who would like to explore the implications of Blockchain technology.

The researcher was driven to fill the gaps observed in existing empirical literature of IT governance, as well as the gaps in Blockchain technology. These gaps are centred on decentralised business models that are causing disruption in the payments industry, in supply chain and in governance. The findings contribute to the ITG body of knowledge by providing insight and in-depth examination of the variables that form decentralisation and how they affect roles like CIO and CTO.

With this research, fellow members of academia, Blockchain entrepreneurs, governance institutes and industry professionals can take away the following lessons:

- Blockchain can be applied to more than just cryptocurrencies.
- Disintermediation does not necessarily eliminate executive roles; however, they can alter the requirements of these roles.
- IT Governance frameworks have room for improvement and must advance with the changes in technology.
- A growing number of communities are beginning to create their own self-governed eco-systems.

- Tacit knowledge, business ethics and intuition have not been substituted by Blockchain and are still key requirements for decision-making.
- Leadership in organisations is being redefined. It is less control-based and more influence oriented.

7.8. Final Word

It has been said that every thesis must tell a compelling story (Hewitt, 2001). This journey has been an insightful experience for the researcher and hopefully for the reader too. The story began with a proposed theory which resulted in months of research and analysis. After a lengthy process of critical thinking, a conclusion was drawn to which the research questions were answered, and from which the substantive aim was achieved.

This story was not written to exist in isolation, it becomes a stepping stone for future research and developments in IT governance, just as other studies were a stepping stone for this one. As such, each body of work must deliver a robust argument so as not to compromise the standards of academia. Throughout the process of telling this story, the researcher faced challenges, limitations and setbacks, thankfully this did not dictate the validity and strength of the final outcome, but rather formed considerations for future studies.

This study demonstrated that the concepts and features of Blockchain can be extended to a variety of situations, IT governance being only one of them.

Creating this body of work has been humbly rewarding. The researcher's passion for the evolution of corporate disciplines will hopefully inspire others to think outside the box as we venture into the fourth industrial revolution.

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9. APPENDIX A: Questionnaire Invitation Letter

COLLEGE OF BUSINESS AND ECONOMICS
DEPARTMENT OF APPLIED INFORMATION SYSTEMS

Research project name: _The Impact of Blockchain Technology on I.T Governance

Participant Information Sheet

We would like to invite you to take part in the above-named study but before you decide, please read the following information.

What is the purpose of this study?

The purpose of the study is to suggest the effect that blockchain technology will have on hierarchical organisations that transition into Decentralised Autonomous Organisations (DAOs). The data collection will be conducted, along with case studies to compare the governance roles and responsibilities required in DAOs versus in hierarchical organisations.

Who is doing the study?

The study is being conducted by Melina M. Katende. A Masters Researcher at the Department of Applied Information Systems at the University of Johannesburg. Melina completed her Honours and undergrad at Kingsway Campus, majoring in Informatics and I.T Management.

Who is being asked to participate?

- IT Directors in Blockchain organisations are being asked to participate.
- Experts in Decentralised Autonomous Organisations. This may include Authors, Speakers, CEOs.

Your rights as a research participant

Participation in this study is completely voluntary and anonymous. Information gathered during the research will be used solely for the purpose of this study and all efforts will be made to ensure the confidentiality of participants' personal information. Please note that while your name will be recorded with the data, it will not be used in the report. All identifiable data will be stored securely on a computer with password-restricted access and only the researcher will have access to it. All identifiable information will be destroyed at the end of the study or after 3 years, whichever comes first. If you decide not to participate there will not be any negative consequences. Please be aware that if you decide to participate, you may withdraw from the study at any time and your data will be destroyed. You may also decide not to answer any specific question.

Benefits to Participants and Others

This research is inductive and aimed at building a new theory. Your contribution will help shape and substantiate the ideology of modern governance in Blockchain organisations. Ultimately this research can be used as a platform for further research or as a guideline for individuals or organisations who would like to explore Blockchain in the future.

Expected Duration of the Questionnaire

15 -20 minutes.

What will happen to the results of the study?

The results will be collated, synthesized using thematic coding and used as a basis for the qualitative analysis. The data collected from the Typeform questionnaire will be destroyed after 8 months. The Typeform account and questionnaire will no longer be active after the end of the Data collection period.

Feedback

If you would like to read the research at the end, kindly fill out your email address at the end of the questionnaire. The full dissertation will be made available upon approval.

For any other queries please contact the Researcher:

Melina M. Katende

10. APPENDIX B: Questionnaire Responses

RESPONDENT	Variable	ANSWER
RESPONDENT#1	QUESTION1	If the DAO needs a physical organisation, the stakeholders will assign an MD of the DAO
RESPONDENT#1	QUESTION2	It must be ensured by documented business processes that are agreed upon and signed of by ll stakeholders. The IT director should guarantee that only agreed policy is implemented in code. An IT director will never be responsible alone, 'product management' & operations will be responsible for defining, IT director will be responsible for correct development, implementation and support
RESPONDENT#1	QUESTION3	No, the value must be there for it's members. They should gain from process optimisations / increased efficiency, increased product or service, increased competitive advantage,... that justifies investments
RESPONDENT#1	QUESTION4	Yes of course
RESPONDENT#1	QUESTION5	Yes he needs tools to manage and reports why the DAO has reason to exists, so yes results should be shared to stakeholders as with any other organisation, internal management reporting and external reporting as required by law
RESPONDENT#1	QUESTION6	By putting all thinkable security measure's in place, having risk specialists covering this and reporting on it. And no never the responsibility of the IT director alone, but risk mitigating measures are always part of the total management debate for the board. A specific measure can be advised from a security perspective, but too expensive for running an cost-effective business, so it should be decided in a board to implement/not implement
RESPONDENT#1	QUESTION7	With implementation technical and legal barriers and on the soft side with creating a culture of high ethical standards
RESPONDENT#2	QUESTION1	I think the DAO still needs some type of charter document, even if it is an online click through, specifying roles and responsibilities. How much and who tests smart contracts before they go live, what is the incident response protocol in case the smart contract or Dapps are misused, what is the SLA expectation around implementing new versions of a ledger protocol.
RESPONDENT#2	QUESTION2	I believe in a consortium operator role. The members of the DAO would choose a technical operator that does not transact as part of the DAO but performs DevOps, testing, security monitoring so that the other participants of the DAO can take assurance the Dapps, network and smart contracts are all operating as expected.
RESPONDENT#2	QUESTION3	Firstly, DAOs should be run in the cloud where costs of goods sold could be standardized and mapped to the role each participant plays in the DAO. Second, the DAO operator should be paid by the participants for the services they provide around uptime, Dapps/smart contract quality development, etc. These can be done as a license agreement, governed via smart contract, that allow each member to measure their specific ROI.
RESPONDENT#2	QUESTION4	Yes I believe there is a business model around operating a DAO.
RESPONDENT#2	QUESTION5	It depends on the charter of the DAO. This could be private or perhaps the voting members opt to make customer satisfaction public such that the DAO operator knows what is working and what needs improving. Use cases and business models will dictate this.
RESPONDENT#2	QUESTION6	By implementing a rigorous information security risk management program. There have to be security standards for hardening the nodes the ledger protocol runs on. Networks should be continually monitored to ensure traffic is legitimately tied to smart contract and Dapp transactions. Smart contracts and Dapps themselves should undergo thorough testing, change management and DevOps procedures.
RESPONDENT#2	QUESTION7	Information processed as part of DAO operations needs to be classified to determine levels of authorization required. If the DAO is processing financial or personal data, then the DAO operator should absolutely institute some type of KYC registration process to vet potential DAO participants prior to granting access to the network. This can all be done remotely so long as it involves two-factor identity checks.
RESPONDENT#3	QUESTION1	That totally depends on the structure of the DAO. The question implies that project management would be different from any other projects. But is that really the case?
RESPONDENT#3	QUESTION2	Again, it really depends on what is actually meant by "a DAO". There is no universal definition, let alone an actual definition of the processes and relationships that are "coded" into a DAO's infrastructure. Code cannot describes arbitrary processes that are followed by people in sufficient detail. That is why the phrase "code is law" is questionable at best. There is always discretionary space for decision making by human beings that is unlikely to be caputed by . Otherwise, it could follow the processes already employed by large software release cycles like the Java community recently adopted.
RESPONDENT#3	QUESTION3	Scaling is not achieved by hardware, but by software architecture (which then might require more or less resources). To me it is unclear, what is meant by "privately" in this

		context. The system might expose metrics that capture the results of a previous measure (more or less adequately - dependent on the definition).
RESPONDENT#3	QUESTION4	No.
RESPONDENT#3	QUESTION5	The question is: Why should that be different from any other project/business?
RESPONDENT#3	QUESTION6	What kind of risks are we talking about (technical, organizaional, monetary, process?)? If it is an open system (public blockchain), one cannot effectively prevent majority of hashpower attacks. Hacks are prevented as in any other IT project/system, why would that be different? Is a hard fork a risk and for whom? The possibility of a hard fork is the direct consequence of choosing DAO as an organisational model. Preventing it is people business and communication/ effort.
RESPONDENT#3	QUESTION7	Same answer as to the previous question. A hack by an individual has nothing to do with teams working remote/in virtual teams - that is common practice even today in many companies that are spread around the globe. So a DAO does not differe w.r.t. to project and team management imo.
RESPONDENT#4	QUESTION1	Perhaps. But it would seem to me that the entire purpose of DAOs as originally conceived was to automate governance.
RESPONDENT#4	QUESTION2	I imagine you'd need some division between the person/group managing the governance protocol and the community to which the DAO serves (which presumably are the ones making the decisions over how those protocols are organized).
RESPONDENT#4	QUESTION3	No idea.
RESPONDENT#4	QUESTION4	Wouldn't that be in the eye of the beholder?
RESPONDENT#4	QUESTION5	I presume it would be similar to typical corporations (again, assuming a capitalist economy).
RESPONDENT#4	QUESTION6	No idea.
RESPONDENT#4	QUESTION7	Not sure.
RESPONDENT#5	QUESTION1	Don't understand what you really mean, but I would assume that employees themselves get together in workshops and create their processes themselves with the mentoring on the side of a process consultant.
RESPONDENT#5	QUESTION2	CIO, CTO types can just trace events on the blockchain.
RESPONDENT#5	QUESTION3	Run everything in trusted cloud provider. Clouds are super cheap and scale by themselves. Nothing then must be worried about.
RESPONDENT#5	QUESTION4	Of course. But why must a director "maintain" that? Just immutably store key events of processes in a set of blockchains and that is enough. Please get over this top-down thinking here. DAOs are all about P2P collaboration.
RESPONDENT#5	QUESTION5	Yes sure, store only KPIs in the blockchains. No point in storing noise on blockchains like in cryptokitties. Keep the noise off chain on regular storing devices.
RESPONDENT#5	QUESTION6	I can not answer this question because the notion of "risk" is a blackbox that could mean anything. If you give me a specific risk then I can give you a concrete answer, I suppose.
RESPONDENT#5	QUESTION7	The DAO hack happened because of the security reviews of the crowdfunding smart-contract code was carried out in the most absurd way. Consequently, there was a protocol exploitation case that resulted in some $60 million being taken out by the exploiter. A technical response would be to perform proper security checks with tool support. That is not possible with Solidity as this language is not rooted in mathematical semantics, differently to smart-contract languages such as Haskell, Erlang, OCaml, etc.
RESPONDENT#6	QUESTION1	Initially through human intervention, with programming protocols set directly for management of projects. Later on, mechanisms can be coded within a DAO.
RESPONDENT#6	QUESTION2	Oversight on an ex-ante and ex-post basis. Ex ante, the code and protocols of the DAO should be implemented carefully before organisational deployment. Ex post, human oversight at regular intervals.
RESPONDENT#6	QUESTION3	Calculating ROI does not change philosophically, it is the increment of return divided by the outlay of investment, expressed as a %. This calculation can be done privately for internal use, or externally as part of a wider transparency initiative, which is one of the goals of DAOs (to be transparent).
RESPONDENT#6	QUESTION4	Accurate, yes; private, oerhaps but not necessarily
RESPONDENT#6	QUESTION5	Yes but it would face the same survey limitations that exist in traditional methodologies
RESPONDENT#6	QUESTION6	A cybersecurity architecture is necessary as in traditional organisations. The difference is that security must be the leading priority in the function of the DAO.
RESPONDENT#6	QUESTION7	IT directors must be proactive in assessing risks and deploying preventive tools, rather than await a crisis. But there is no foolproof way to totally secure a DAO
RESPONDENT#7	QUESTION1	No. It would require a collaborative leadership role where all stakeholders are equally accountable determined by their contribution to a project. A larger emphasis will be put on self organised structures rather than appointed ones
RESPONDENT#7	QUESTION2	With a clear focus on establishing trusted and transparent communication channels it is not solely the IT directors responsibility alone

RESPONDENT#7	QUESTION3	Consensus mechanisms underpinning objective and transparent reporting mechanism will provide data that is public and open to discussion
RESPONDENT#7	QUESTION4	No
RESPONDENT#7	QUESTION5	Metrics are important however they need to be relevant and driving intended behaviours. KPI s should focus on incetive model and should be transparent and objective
RESPONDENT#7	QUESTION6	Effective scenario planning strategies which are constantly reviewed. Risk mitigation is a collective responsibility
RESPONDENT#7	QUESTION7	Know Your Colleague (KYC). A new term which will become more common in the future and is linked back to individuals taking back ownership of their digital identities. In a future world where immutable trust will make it more difficult for deception and IT directors will need to adapt to different recruitment screening processes when hiring and assessing an agent's ability to be trusted
RESPONDENT#8	QUESTION1	We are not there yet, figuring out the governance models of the future, including how to implement programmes will require a lot of expirementation.
RESPONDENT#8	QUESTION2	Well just like Bitcoin does not have a individual governance group (cio, ceo, cto, cisco...), the network in itself is comprised of a governing body of developers of blockchain. They would be responsible for maintaining the protocol as a group.
RESPONDENT#8	QUESTION3	scaling would have to be based on the consensus of the group. there are groups of individuals that have forked from ethereum and bitcoin and it has worked for them.
RESPONDENT#8	QUESTION4	No. If it is private it is no longer decentralised.
RESPONDENT#8	QUESTION5	they could make it part of the protocol. and install a separate application layer to calculate those figures.
RESPONDENT#8	QUESTION6	Risk is shared in a DAO. that is why it is risky to invest in ICO because you are not sure of the outcome yet are part of the ecosystem.
RESPONDENT#8	QUESTION7	although you do not know all participants in a decentralise network, trust can be built over time by observing individual's activity history on the system. that would probably require another application to report on activity.
RESPONDENT#9	QUESTION1	This is something to explore.
RESPONDENT#9	QUESTION2	Depending on the lifecycle of the DAO, either the founder or the network of people could decide on the governance protocol. In the begining, the first few people get to decide on thta, they would be responsible for ensuring the protocol is aligned with business rules and policies. But in terms of enforcement of the protocol, no selected people have all the control legally or technically.
RESPONDENT#9	QUESTION3	incentivizing users to contribute would ensure that the software is optimal for all users.
RESPONDENT#9	QUESTION4	No
RESPONDENT#9	QUESTION5	run an ICO before launching and hope for the best. there are no guarantees on stakeholder satisfaction once the DAO is launched.
RESPONDENT#9	QUESTION6	there will always be risks, regulatory, market and technical risks. this would be the responsibility of the group as a whole. there is no way a single director could oversee all the risks if the blockchain scales as large as bitcoin for example.
RESPONDENT#9	QUESTION7	similar to previous question. network would have to manage risks and be incentives to do so
RESPONDENT#10	QUESTION1	A programme could be implemented over different life cycles in the DAO, but that needs to be coded.
RESPONDENT#10	QUESTION2	get volunteers to assist. and provide incentives.
RESPONDENT#10	QUESTION2	some DAOs seek the direction of external policy advisors but still allow the network to makes its own decisions. Its all quite flexible.
RESPONDENT#10	QUESTION3	set hard coded rules on productivity. Nothing wrong with suspending unproductive members in a private DAO. if the protocol allows
RESPONDENT#10	QUESTION4	Yes. Its the heart of capitalism. many confuse Blockchain and economic systems. Companies can still use the technology whilst being capitalists, which gives them the right keep certain information private.
RESPONDENT#10	QUESTION5	anyone in the world , including stakeholders can participate in DAOs. If you work with something like Aragon, you can see the governance model playing out in real time and see people's voting. so you'd be able to access metrics related to stakeholder satisfaction that way.
RESPONDENT#10	QUESTION6	they'd have to observe the network often or could appoint blockchain auditors.
RESPONDENT#10	QUESTION7	If its a private or consortium blockchain, they would have to do background checks just the same wayas hierarchical organisations.

11. APPENDIX C – Data Coding Allocation

* The original text from Respondents has not been edited and therefore may include typing errors.

Question	Respondent	Text*	Code	Reason for Code Allocation.
QUESTION2	RESPONDENT#1	It must be ensured by documented business processes that are agreed upon and signed of by the stakeholders. The IT director should guarantee that only agreed policy is implemented in code. An IT director will never be responsible alone, 'product management' & operations will be responsible for defining, IT director will be responsible for correct development, implementation and support	Conventional IT Governance	This sentiment is leans more towards conventional governance because it includes traditional methods of assigning roles. This is typically found in the RACI charts.
QUESTION3	RESPONDENT#1	No, the value must be there for it's members. They should gain from process optimisations / increased efficiency, increased product or service, increased competitive advantage, that justifies investments	Unconventional IT Governance	This emphasises community and the distribution of benefits for all. A common theme of decentralization.
QUESTION4	RESPONDENT#1	Yes of course.	Conventional IT Governance	Self-Explanatory.
QUESTION5	RESPONDENT#1	Yes he needs tools to manage and reports why the DAO has reason to exists, so yes results should be shared to stakeholders as with any other organisation, internal management reporting and external reporting as required by law	Conventional IT Governance	This is the same process that hierarchical organisations run.
QUESTION6	RESPONDENT#1	By putting all thinkable security measure's in place, having risk specialists covering this and reporting on it. And no never the responsibility of the IT director alone, but risk mitigating measures are always part of the total management debate for the board. A specific measure can be advised from a security perspective, but too expensive for running a cost-effective business, so it should be decided in a board to implement/not implement	Conventional IT Governance	This is the same risk management process that hierarchical organisations run. It is mentioned in COBIT 5.
QUESTION7	RESPONDENT#1	With implementation technical and legal barriers and on the soft side with creating a culture of high ethical standards	Conventional IT Governance	Creating ethical standards is something that is usually done in hierarchical organisations because it requires communication, awareness and team building.
QUESTION1	RESPONDENT#2	I think the DAO still needs some type of charter document, even if it is an online click through, specifying roles and responsibilities. How much and who tests smart contracts before they go live, what is the incident response protocol in case the smart contract or Dapps are misused, what is the SLA expectation around implementing new versions of a ledger protocol.	Unconventional IT Governance	The respondent mentioned a conventional practice but suggested an unconventional way of achieving it.
QUESTION2	RESPONDENT#2	I believe in a consortium operator role. The members of the DAO would choose a technical operator that does not transact as part of the DAO but performs DevOps, testing, security monitoring so that the other participants of the DAO can take assurance the Dapps, network and smart contracts are all operating as expected.	Unconventional IT Governance	This is not something mentioned in COBIT 5. There is a mention of Dapps and smart contracts. Which are common attributes of decentralization.

QUESTION3	RESPONDENT#2	Firstly, DAOs should be run in the cloud where costs of goods sold could be standardized and mapped to the role each participant plays in the DAO. Second, the DAO operator should be paid by the participants for the services they provide around uptime, Dapps/smart contract quality development, etc. These can be done as a license agreement, governed via smart contract, that allow each member to measure their specific ROI.	Unconventional IT Governance	The respondent mentioned a conventional practice but suggested an unconventional way of achieving it.
QUESTION4	RESPONDENT#2	Yes I believe there is a business model around operating a DAO.	Unconventional IT Governance	Self-Explanatory.
QUESTION5	RESPONDENT#2	It depends on the charter of the DAO. This could be private or perhaps the voting members opt to make customer satisfaction public such that the DAO operator knows what is working and what needs improving. Use cases and business models will dictate this.	Unconventional IT Governance	The respondent mentioned a conventional practice but suggested an unconventional way of achieving it.
QUESTION6	RESPONDENT#2	By implementing a rigorous information security risk management program. There have to be security standards for hardening the nodes the ledger protocol runs on. Networks should be continually monitored to ensure traffic is legitimately tied to smart contract and Dapp transactions. Smart contracts and Dapps themselves should undergo thorough testing, change management and DevOps procedures.	Conventional IT Governance	This process is almost exactly what is mentioned in COBIT 5.
QUESTION7	RESPONDENT#2	Information processed as part of DAO operations needs to be classified to determine levels of authorization required.	Unconventional IT Governance	Self-Explanatory.
QUESTION7	RESPONDENT#2	If the DAO is processing financial or personal data, then the DAO operator should absolutely institute some type of KYC registration process to vet potential DAO participants prior to granting access to the network.	Conventional IT Governance	This sentiment advocates for conventional ways of accessing information. It is restrictive and leads to centralized governance.
QUESTION1	RESPONDENT#3	That totally depends on the structure of the DAO. The question implies that project management would be different from any other projects. But is that really the case?	Ambiguous	This answer is ambiguous because it does not mention any processes that are exclusively conventional or unconventional governance. It mentions project management which is separate to governance. Hence why it has been excluded as a governance process.
QUESTION2	RESPONDENT#3	Again, it really depends on what is actually meant by "a DAO". There is no universal definition, let alone an actual definition of the processes and relationships that are "coded" into a DAO's infrastructure. Code cannot describes arbitrary processes that are followed by people in sufficient detail. That is why the phrase "code is law" is questionable at best. There is always discretionary space for decision making by human beings that is unlikely to be caputed by . Otherwise, it could follow the processes already employed by large software release cycles like the Java community recently adopted.	Ambiguous	This statement speaks of unconventional processes, the main sentiment is ambiguous . The respondent uses terms like "It Depends" … indicating that it could be either conventional or unconventional.
QUESTION3	RESPONDENT#3	Scaling is not achieved by hardware, but by software architecture (which then might require more or less resources). To me it is unclear, what is meant by "privately" in this context. The system might expose metrics that capture the results of a previous measure (more or less adequately - dependent on the definition).	Ambiguous	The respondent was unsure about the meaning of the question. This answer is not straightforward and was therefore coded as Ambiguous.
QUESTION4	RESPONDENT#3	No	Unconventional IT Governance	Self-Explanatory.

QUESTION5	RESPONDENT#3	The question is: Why should that be different from any other project/business?	Conventional IT Governance	This statement implies that there is no difference between regular hierarchical and decentralised governance.
QUESTION6	RESPONDENT#3	What kind of risks are we talking about (technical, organizaional, monetary, process?)? If it is an open system (public blockchain), one cannot effectively prevent majority of hashpower attacks. Hacks are prevented as in any other IT project/system, why would that be different? Is a hard fork a risk and for whom? The possibility of a hard fork is the direct consequence of choosing DAO as an organizational model. Preventing it is people business and communication/ effort.	Conventional IT Governance	This answer reveals that perhaps the question was unclear to the respondent. However, the main sentiment is relates to conventional governance approaches.
QUESTION6	RESPONDENT#3	Preventing it is people business and communication/ effort.	Conventional IT Governance	This is question was about risk management. It is a typical process outlined in COBIT 5.
QUESTION7	RESPONDENT#3	Same answer as to the previous question. A hack by an individual has nothing to do with teams working remote/in virtual teams - that is common practice even today in many companies that are spread around the globe. So a DAO does not differe w.r.t. to project and team management imo.	Conventional IT Governance	Same as above.
QUESTION1	RESPONDENT#4	Perhaps. But it would seem to me that the entire purpose of DAOs as originally conceived was to automate governance.	Unconventional IT Governance	This seems to be an assumption, but the sentiment leans clearly toward unconventional governance.
QUESTION2	RESPONDENT#4	I imagine you'd need some division between the person/group managing the governance protocol and the community to which the DAO serves (which presumably are the ones making the decisions over how those protocols are organized)	Unconventional IT Governance	Self-Explanatory.
QUESTION3	RESPONDENT#4	No idea.	Ambiguous	Self-Explanatory.
QUESTION4	RESPONDENT#4	Wouldn't that be in the eye of the beholder?	Ambiguous	Self-Explanatory.
QUESTION5	RESPONDENT#4	I presume it would be similar to typical corporations (again, assuming a capitalist economy).	Conventional IT Governance	This is the second mention of capitalism, which is closely related to open free markets that often lead to oligopolies and centralisation. Therefore, this sentiment leans more toward conventional centralised governance.
QUESTION6	RESPONDENT#4	No idea.	Ambiguous	Self-Explanatory.
QUESTION7	RESPONDENT#4	Not sure.	Ambiguous	Self-Explanatory.

QUESTION1	RESPONDENT#5	Don't understand what you really mean, but I would assume that employees themselves get together in workshops and create their processes themselves with the mentoring on the side of a process consultant.	Unconventional IT Governance	Self-Explanatory.
QUESTION2	RESPONDENT#5	CIO, CTO types can just trace events on the blockchain.	Unconventional IT Governance	This is not something specified in COBIT 5.
QUESTION3	RESPONDENT#5	Run everything in trusted cloud provider.	Conventional IT Governance	This answer has both conventional and ambiguous sentiments. It is common nowadays to run certain parts of enterprises online.
QUESTION3	RESPONDENT#5	Run everything in trusted cloud provider. Clouds are super cheap and scale by themselves. Nothing then must be worried about.	Ambiguous	In the second part of this response to Question 3, there is no definitive sentiment of unconventional or conventional governance. The respondent says nothing must be worried about but does not mention what that entails.
QUESTION4	RESPONDENT#5	Of course. But why must a director "maintain" that? Just immutably store key events of processes in a set of blockchains and that is enough. Please get over this top-down thinking here. DAOs are all about P2P collaboration.	Conventional IT Governance	Self-Explanatory.
QUESTION5	RESPONDENT#5	Yes sure, store only KPIs in the blockchains. No point in storing noise on blockchains like in cryptokitties. Keep the noise off chain on regular storing devices.	Unconventional IT Governance	Self-Explanatory.
QUESTION6	RESPONDENT#5	I can not answer this question because the notion of "risk" is a blackbox that could mean anything. If you give me a specific risk then I can give you a concrete answer, I suppose.	Ambiguous	Self-Explanatory.
QUESTION7	RESPONDENT#5	The DAO hack happened because of the security reviews of the crowdfunding smart-contract code was carried out in the most absurd way. Consequently, there was a protocol exploitation case that resulted in some $60 million being taken out by the exploiter. A technical response would be to perform proper security checks with tool support. That is not possible with Solidity as this language is not rooted in mathematical semantics, differently to smart-contract languages such as Haskell, Erlang, OCaml, etc.	Unconventional IT Governance	This is not a typical process as explained in COBIT 5.
QUESTION1	RESPONDENT#6	Initiappy through hunan intervention, with programming protocols set directly for management of projects. Later on, mechanisms can be coded within a DAO.	Unconventional IT Governance	This is not a typical process as explained in COBIT 5.
QUESTION2	RESPONDENT#6	Oversight on an ex-ante and ex-post basis. Ex ante, the code and protocols of the DAO should be implemented carefully before organizstional deployment. Ex post, human oversight at regular intervals.	Unconventional IT Governance	This is not a typical process as explained in COBIT 5.

QUESTION3	RESPONDENT#6	Calculating ROI does not change philosophically, it is the increment of return divided by the outlay of investment, expressed as a %. This calculation can be done privately for internal use,	Conventional IT Governance	Self-Explanatory.
QUESTION3	RESPONDENT#6	or externally as part of a wider transparency initiative, which is one of the goals of DAOs (to be transparent).	Unconventional IT Governance	This is a common theme of governance in DAOs. The respondent mentions transparency. This is not a typical process of hierarchical governance, to share all financial information with all employees.
QUESTION4	RESPONDENT#6	Accurate, yes; private, oerhaps but not necessarily	Unconventional IT Governance	This answer leans towards unconventional because it suggests that it is not necessary to keep certain information private. This is the main theme of decentralisation.
QUESTION5	RESPONDENT#6	Yes but it would face the same survey limitations that exist in traditional methodologies	Conventional IT Governance	Self-Explanatory.
QUESTION6	RESPONDENT#6	A cybersecurity architecture is necessary as in traditional organizations. The difference is that security must be the leading priority in the function of the DAO.	Conventional IT Governance	Cybersecurity strategies are common suggestion not only from COBIT 5 but ISO standards. These are difficult to implement in a central way in DAOs.
QUESTION7	RESPONDENT#6	IT directors must be proactive in assessing risks and deploying preventiventools, rather than await a crisis. But there is no foolproof way to totally secure a DAO	Unconventional IT Governance	Self-Explanatory.
QUESTION1	RESPONDENT#7	No. It would require a collaborative leadership role where all stakeholders are equally accountable determined by their contribution to a project. A larger emphasis will be put on self organised structures rather than appointed ones	Unconventional IT Governance	Self-Explanatory.
QUESTION2	RESPONDENT#7	With a clear focus on establishing trusted and transparent communication channels it is not solely the IT directors responsibility alone	Conventional IT Governance	Self-Explanatory.
QUESTION3	RESPONDENT#7	Consensus mechanisms underpinning objective and transparent reporting mechanism will provide data that is public and open to discussion	Unconventional IT Governance	Self-Explanatory.
QUESTION4	RESPONDENT#7	No	Unconventional IT Governance	Self-Explanatory.
QUESTION5	RESPONDENT#7	Metrics are important however they need to be relevant and driving intended behaviours. KPI s should focus on incetive model and should be transparent and objective	Unconventional IT Governance	Self-Explanatory.

QUESTION6	RESPONDENT#7	Effective scenario planning strategies which are constantly reviewed. Risk mitigation is a collective responsibility	Conventional IT Governance	This is a typical process as explained in COBIT 5. A Part of Risk Management is mitigation and regular monitoring.
QUESTION7	RESPONDENT#7	Know Your Colleague (KYC). A new term which will become more common in the future and is linked back to individuals taking back ownership of their digital identities. In a future world where immutable trust will make it more difficult for deception and IT directors will need to adapt to different recruitment screening processes when hiring and assessing an agent's ability to be trusted	Unconventional IT Governance	This is a new term that does not yet exist in COBIT 5, also the process introduces new aspect to governance.
QUESTION1	RESPONDENT#8	We are not there yet, figuring out the governance models of the future, including how to implement programmes will require a lot of expirementation.	Ambiguous	It appears the respondent is unsure what Programme would be implement. This is normal as it is still a new concept. However, the answer does not provide any definitive indication of conventional or unconventional.
QUESTION2	RESPONDENT#8	Well just like Bitcoin does not have a individual governance group (cio, ceo, cto, cisco...), the network in itself is comprised of a governing body of developers of blockchain. They would be responsible for maintaining the protocol as a group.	Unconventional IT Governance	Self-Explanatory.
QUESTION3	RESPONDENT#8	scaling would have to be based on the consensus of the group. there are groups of individuals that have forked from ethereum and bitcoin and it has worked for them.	Unconventional IT Governance	Self-Explanatory.
QUESTION4	RESPONDENT#8	No. If it is private it is no longer decentralised.	Unconventional IT Governance	Self-Explanatory.
QUESTION5	RESPONDENT#8	they could make it part of the protocol. and install a separate application layer to calculate those figures.	Ambiguous	This answer does not provide a definitive governance approach that is either conventional or unconventional.
QUESTION6	RESPONDENT#8	Risk is shared in a DAO. that is why it is risky to invest in ICO because you are not sure of the outcome yet are part of the ecosystem.	Unconventional IT Governance	This is a typical scenario of Blockchain, ICOs. They operate using decentralisation and distribution. Not a conventional approach of organisation governance as laid out in COBIT 5.
QUESTION7	RESPONDENT#8	although you do not know all participants in a decentralise network, trust can be built over time by observing individual's activity history on the system. that would probably require another application to report on activity.	Unconventional IT Governance	Self-Explanatory.
QUESTION1	RESPONDENT#9	this is somethign to explore.	Ambiguous	Self-Explanatory.
QUESTION2	RESPONDENT#9	Depending on the lifecycle of the DAO, either the founder or the network of people could decide on the governance protocol. In the beginning, the first few people get to decide on thta, they would be responsible for ensuring the protocol is aligned with business rules and policies. But in terms of enforcement of the protocol, no selected people have all the control legally or technically	Ambiguous	The respondent mentions that this answer depends on different factors. This indicates that it could either be conventional or unconventional, therefore it is ambiguous.

QUESTION3	RESPONDENT#9	incentivising users to contribute would ensure that the software is optimal for all users.	Unconventional IT Governance	This is not a typical process as explained in COBIT 5.
QUESTION4	RESPONDENT#9	No	Unconventional IT Governance	Self-Explanatory.
QUESTION5	RESPONDENT#9	run an ICO before launching and hope for the best. there are no guarantees on stakeholder satisfaction once the DAO is launched.	Unconventional IT Governance	ICOs are a new phenomenon, not a typical process as explained in COBIT 5.
QUESTION6	RESPONDENT#9	there will always be risks, regulatory, market and technical risks. this would be the responsibility of the group as a whole. there is no way a single director could oversee all the risks if the blockchain scales as large as bitcoin for example.	Unconventional IT Governance	This is not a typical process as explained in COBIT 5.
QUESTION7	RESPONDENT#9	similar to previous question. network would have to manage risks and be incentives to do so	Unconventional IT Governance	Same as above.
QUESTION1	RESPONDENT#10	A programme could be implemented over different life cycles in the DAO, but that needs to be coded.	Unconventional IT Governance	This is a suggestion and quite creative. It is not a typical process as explained in COBIT 5.
QUESTION2	RESPONDENT#10	get volunteers to assist. and provide incentives. some DAOs seek the direction of external policy advisors but still allow the network to makes its own decisions.its all quite flexible.	Unconventional IT Governance	This is not a typical process as explained in COBIT 5.
QUESTION3	RESPONDENT#10	set hard coded rules on productivity.nothing wrong with suspending unproductive members in a private DAO. if the protocol allows	Unconventional IT Governance	This is not a typical process as explained in COBIT 5.
QUESTION4	RESPONDENT#10	Yes. Its the heart of capitalism. many confuse Blockchain and economic systems. Companies can still use the technology whilst being capitalists, which gives them the right keep certain information private.	Conventional IT Governance	Capitalism is an Economic system based on the private ownership , it typically results in the centralisation of information.
QUESTION5	RESPONDENT#10	anyone in the world , including stakeholders can participate in DAOs. If you work with something like Aragon, you can see the governance model playing out in real time and see people's voting. so you'd be able to access metrics related to stakeholder satisfaction that way.	Conventional IT Governance	This practice of stakeholder management is common and suggested in COBIT 5. There is an emphasis on ensuring stakeholder satisfaction. Which is one of the core principles of COBIT 5.
QUESTION6	RESPONDENT#10	they'd have to observe the network often or could appoint blockchain auditors.	Conventional IT Governance	This is synonymous with the control part of the hierarchical governance structure.